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ARTISTIC MUNICIPAL AUDITORIUM BUILT BY SAN ANTONIO, TEXAS, CAPABLE OF SEATING AS MANY AS SEVEN THOUSAND PERSONS

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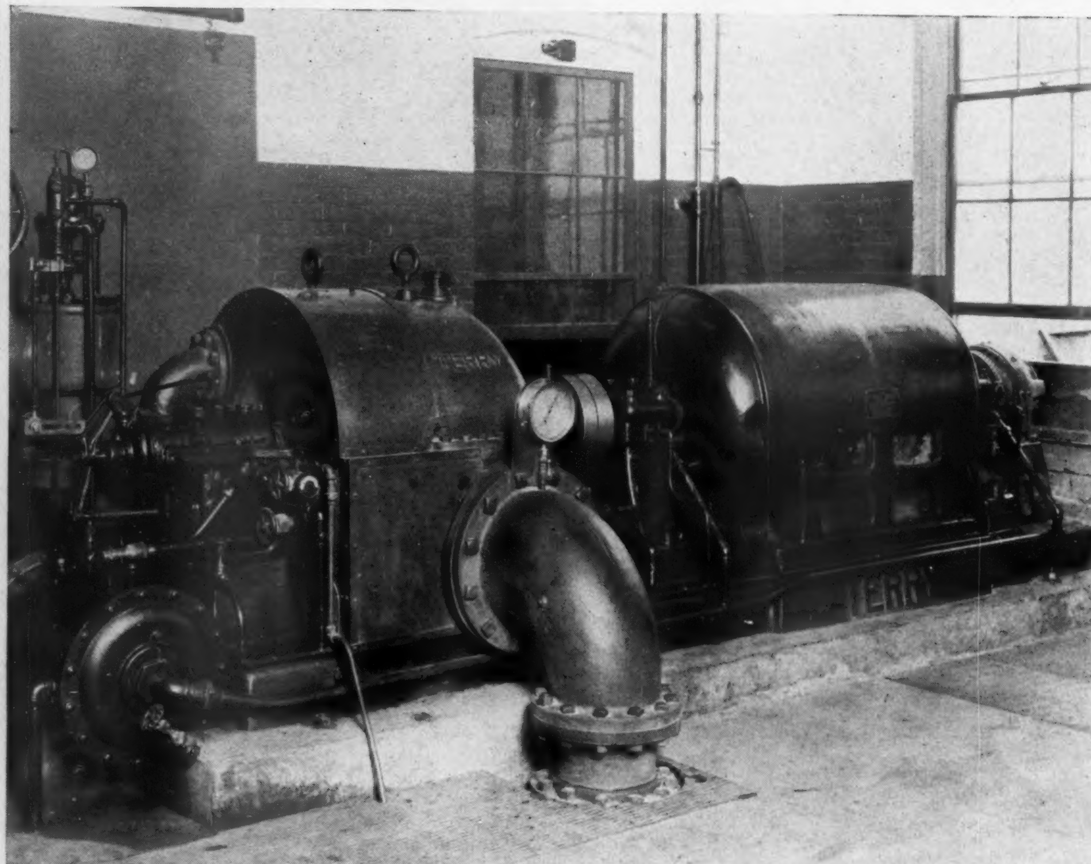
TERRY



"TO OUR ENTIRE SATISFACTION"

Thus writes Mr. W. W. Robertson, superintendent of the Orford Soap Company of Manchester, Conn. in referring to the 300 K.W. TERRY he installed in 1924.

He states further — "It has been in continuous service a large part of the time night and day. We use the exhaust steam for heating and process work and the whole apparatus has been operated to our entire satisfaction, doing all that we expected it would do."

The **Terry Steam Turbine Company**
TERRY SQUARE, HARTFORD, CONN.
Steam Turbines - Gears - Shaft Couplings

As It Seems To Us

PANAMA CANAL TRAFFIC MAKES NEW RECORD

DURING the year gone, the Panama Canal established a new record for itself not only in the number of vessels passing through it but also in the sum of the tolls collected. According to a special dispatch to the *New York Times*, a total of 6,430 commercial-vessel transits were made during 1929—representing 106 more transits than were made during the preceding year. Those craft paid a matter of $27,592,150—a daily average of $75,596. This means that since the canal was opened in August of 1919 the transit revenues have amounted to $223,850,116—ample evidence that the interocean route is paying handsomely for the expenditures made upon it.

While the average of daily transits made in 1929 is just short of eighteen, the estimated present capacity of the canal is put at about 50 ships per diem with 24-hour operation of the waterway. An additional set of locks would augment the capacity to 75 ships; and the purpose of the Madden Dam, now under construction, is to provide the necessary reserve of water that would be needed by an increase in the number of "lockings" occurring in the course of each day. Traffic demands are not likely to overtax the canal for years to come. The Madden Dam was authorized by Congress in 1928, and should be completed within a period of five years. The estimated cost was put at $12,000,000. The dam will be 170 feet high. It will create a reservoir covering a superficial area of 22 square miles and be capable of storing 22,000,000,000 cubic feet of water.

SEVENTEEN MILLION MORE OF US THAN A DECADE AGO

WE HAVE it on the authority of the United States Bureau of the Census that our population has increased substantially 17,000,000 in the course of the last ten years. This means that our total population will be found to be around 122,000,000 when the 1930 census is completed. While this evidence of growth is significant of the increasing pace of our onward march in the realm of human progress, still we have yet a long way to go to measure numerically with a number of other countries that still cling to age-old habits of life and to far more leisurely ways of doing the things that contribute to social and economic relations.

Most people look upon the national census primarily as a gage of population; but as a matter of fact that is the least important angle of the great work. The real purpose of the census is to reveal fundamental details concerning all phases of our economic life and the contributive parts played by every department of industry—industry meaning every line of productive or gainful endeavor. In short, the census is a veritable cross section of a multitude of things that contribute to our standing as a nation and to our well-being as a people.

Each one of us will be asked to answer twenty or more questions; and with the exception of the disturbing query as to age, the majority of the answers will be reasonably close to the facts. When all this data is classified and tabulated we shall have at our disposal a wealth of worth-while information; and the gathering, compiling, and publishing of this material will cost but the paltry sum of thirty cents per capita.

FASTER GROWING STRAIN OF WHEAT PRODUCED

IN AN infrequently visited section of New Mexico there has recently been found a cave, with walls adorned with paintings, that was probably last occupied something like 4,000 years ago by Indians that had attained to considerable cultural development. Buried in the ashes of fires used for cooking by the remote inhabitants the discoverers found cobs of Indian maize which served so widely as a foodstuff for the aborigines of America. The uncovered cobs, scarcely larger than a cigar, indicate how much has since been done through agricultural research and experimentation in producing the robust ears of the corn of today. This field of human endeavor is a fascinating one and exemplifies what man can accomplish in the way of amplifying the productiveness of a given species and, incidentally, the potential fruitfulness of the unit acre.

Our wheaten loaf reflects today what has been similarly achieved in the course of years in evolving types of wheat capable of yielding abundant crops under wide ranges of climatic conditions. That this vastly important line of effort is being followed persistently was evidenced when JOSEPH H. B. SMITH was awarded the 1929 wheat prize a short while back at the International Grain and Hay Show held in Chicago. By experimenting and by crossing, Mr. SMITH produced what is known as "Reward Wheat", which matures in less than 100 days from planting! This is a very valuable characteristic, because it will make it practicable to plant and to harvest wheat in otherwise fertile territories where the summers or growing seasons are short. It is reported that "Reward Wheat" will be used to plant a region of 48,000,000 acres in Canada where cereal cultivation has hitherto not been considered possible. Thus science and research assure us our daily loaf in the years to come even though we may greatly increase in numbers and encroach more and more upon the acres now given over to farming. Furthermore, it is not unlikely that the researcher may yet produce other strains of wheat that will grow even faster and thus extend the cultivation of cereals into lands still farther north.

WHY BE ABSTEMIOUS?

WE ARE still near enough to New Year's to recall the annual habit of making reformatory resolutions; and many of us have already reached that stage where we are beginning to question the wisdom of our promised denials. Confirmation of this is to be had in the husky example of one WILLIAM WALKER, 98 years old, residing in Trappe, Md., located in the famous Eastern Shore section of the State where the dietary good things of life are notably abundant.

Despite his advanced years, WILLIAM WALKER can thread a fine needle without the use of glasses; and he does many chores around his home that would weary and perhaps be too much for most men years younger. The Institute for Biological Research of Johns Hopkins University has sought data from WILLIAM WALKER in quest of information regarding the reasons for his ruggedness in his very ripe old age; and it seems that this near-centenarian has been smoking a pipe since he was ten years old; has chewed tobacco since he was fifteen; still has most of his teeth; and enjoys a drink of good whiskey occasionally. His appetite is unfailing, and he is ready and hungry for each of the three square meals eaten daily. He is reported to have said that he is particularly fond of fish, oysters, and crabs—in short, likes anything that comes out of the water. He is mentally exceptionally keen, and recalls readily things that happened half a century ago.

Why be abstemious if WILLIAM WALKER has not denied himself and yet is robust and serviceable when nearly a hundred years old? Possibly the one outstanding reason for his unusual vigor is, according to his own account, that he has worked hard all his life. Undoubtedly, a vast majority of us would be in finer shape and able to enjoy much that we are warned against if we had spent more time working hard in the way that Nature intends we should. All our faculties would then be in a healthy condition and our mental attitude towards life would reflect that physical status. In short, we should not feel the need of "swearing off" just once so often.

Ewing Galloway, New York

Some of the modern genii that rear America's wonder structures.

This illustration, from "Harper's Weekly" of 1868, shows how silver was moved under armed escort from the Real del Monte mines to the City of Mexico.

History of Mexico's Richest Silver Mines

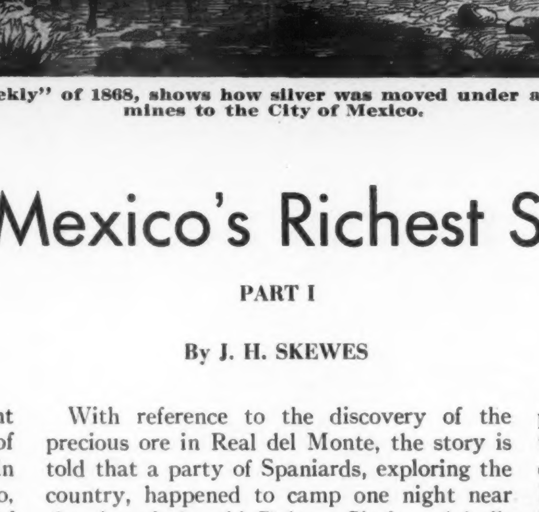
PART I

By J. H. SKEWES

ONE OF the largest and most important silver-mining camps in the Republic of Mexico, and probably in the world, is in Pachuca, the capital of the State of Hidalgo, which is situated about 60 miles northeast of Mexico City at an altitude of 8,000 feet above sea level and has a population of 50,000. Pachuca is a Castilian corruption of the Toltec word Pachuacan—meaning "near a gulch", the name given the city by its Toltec founders. The Spaniards afterwards renamed it Pachuca. It is a typical mining-camp town surrounded by high mountains of the Sierra de Pachuca range, which is dotted with scores of stone monuments marking the corners of mining claims. These now barren mountains, so some of the older inhabitants claim, were once thickly wooded —the trees that grew there having been cut for mining purposes and for fuel.

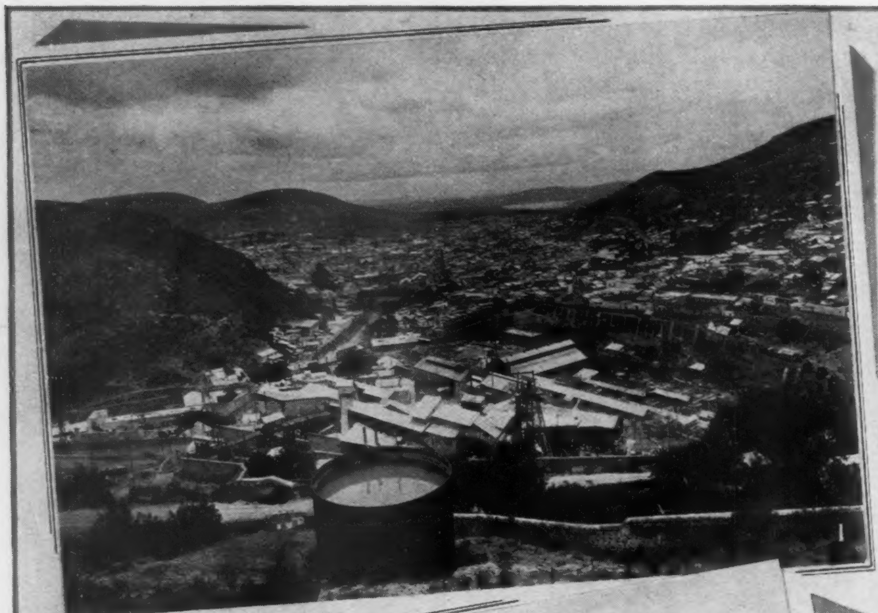
The history of the camp is very interesting, as it is one of the oldest Spanish settlements in the country. Silver ore was first discovered in 1534 in what is today the little mining town of Real del Monte, which lies at an elevation of 9,000 feet slightly to the northeast and about five miles from Pachuca, and numbers 10,000 people. This community is very picturesque and, like Pachuca, is encircled by mountains that are, however, covered with dense forests. One of these mountains, El Zumate, rises to a height of 11,000 feet and is said to be the loftiest peak in the State of Hidalgo.

With reference to the discovery of the precious ore in Real del Monte, the story is told that a party of Spaniards, exploring the country, happened to camp one night near the site of the old Dolores Shaft and built their camp fire on an outcropping of the Santa Brígida vein. Imagine their surprise next morning, when they saw molten silver running from the rocks beneath the fire. Be that as it may, the fact remains that subsequent mining operations proved this vein to be a big producer and exceptionally rich in places—some of the workings extending up to "grass roots". Later, the Spaniards discovered ore in Pachuca; and the Xacal and Rosario mines in that district were exploited by them for many years, as were also the Santa Brígida and Vizcaina veins in Real del Monte. In 1557, Friar Bartolome de Medina invented, at Pachuca, the patio process for amalgamating silver ores, and this was used in the region for nearly three and a half centuries after its discovery.



A 54-inch weir at the Dos Carlos Mine, Pachuca. This water is raised 1,440 feet in one lift.

In 1739 a Spaniard, named Pedro Romero de Terreros, acquired ownership of the mines for a comparatively small sum of money; and, being energetic and enterprising, he worked them on a large scale. Fortune favored him, for soon afterwards rich ore was found in both the Pachuca and Real del Monte mines. Torreros became fabulously wealthy and made large loans and presents to the King of Spain, by whom he was knighted and given the title of Conde de Regla. It was Terreros who established the national pawnshop in Mexico City, where a bronze bust of the founder may today be seen atop one of the arches decorating this building. Several other interesting buildings erected by his orders are still standing. These include the Casas Coloradas, in Pachuca, now used for government offices, and the Casa del Conde and the Casa Grande in Real del Monte. The first was supposed to have been the residence of the Conde



1—Pachuca, as seen from a point overlooking the Loreto Mill of the Real del Monte Company.

2—San Rafael Mill and patio, Pachuca.

3—Loreto Mill and refinery of the Real del Monte Company, Pachuca.

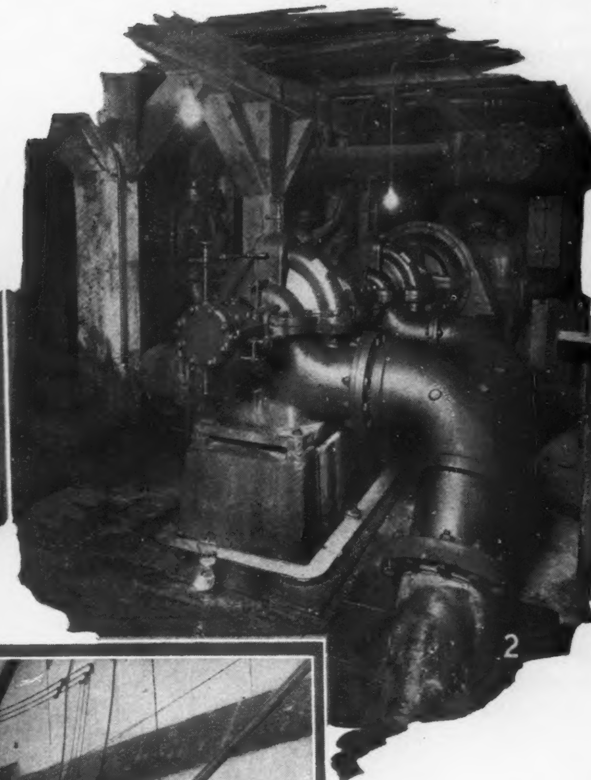
de Regla and, until partly destroyed by fire a few years ago, served as a boarding house for employees of one of the local mining companies. The Casa Grande is the home of the company's general superintendent of mines.

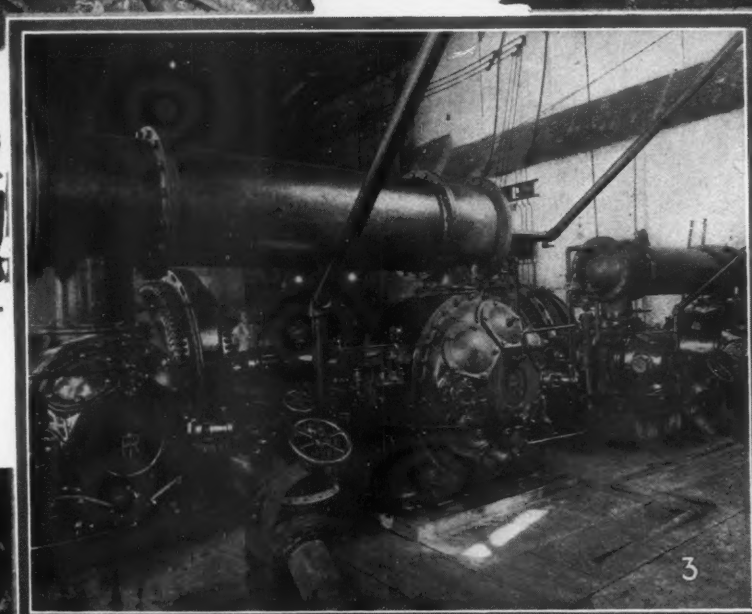
It is recorded that during the time Terreros worked the mines they produced ore to the value of more than 10,000,000 pesos notwithstanding the rather crude methods then employed and the difficulties encountered. As the mines got deeper, large quantities of water hindered operations because the flow could not be handled for want of adequate pumping equipment. An effort was made to lower the water by using horse *malacates*, or whims, to hoist the water out in buckets made from bullock hides and operating continuously in seventeen different shafts. The Morán Adit in the creek bed near the old Morán Mine, about a mile to the east and approximately 558 feet below Real del Monte, was started at this time in an attempt to unwater the workings. But all these measures proved of no avail, for a sudden increase in the flow inundated the mines with the result that operations were practically suspended near the end of the seventeenth century. The Morán Adit was later advanced by other companies and, ultimately, had a length, including its several branches, of 6.2 miles. History records that Baron Alexander von Humboldt visited the mines of Pachuca and Real del Monte in 1803; and his memoirs give an account of the great riches in the flooded mines.

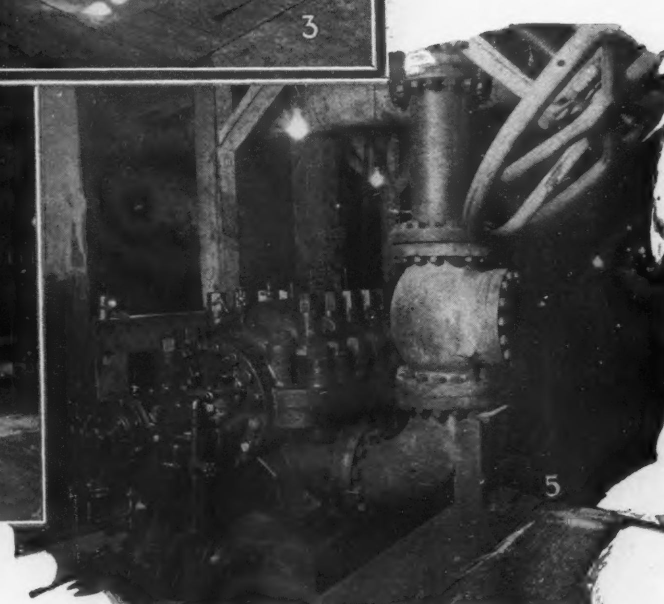
In 1824, the John Taylor Company was formed in London, England, to work the mines, and several hundred Cornish miners with their families were sent out to Pachuca. Some of their descendants may still be found there. Cornish steam pumps and hoists were also shipped from England by way of Vera Cruz—the laborious task of getting them to the properties may well be imagined when it is realized that all this heavy machinery was dragged up the steep grades from Vera Cruz. The company built a good road from Pachuca to Real del Monte. It was blasted out of the solid rock of the mountainside, and then represented something of an undertaking and engineering achievement. It is in use today, and is kept in repair by the present operators—being considered one of the best mountain roads in the country.

The first three Cornish pumps in Real del Monte were installed at the Terreros, San Cayetano, and Dolores shafts. As soon as they were running and the steam hoists were ready for service, the shafts were carried down to the 984-foot level and a drainage tunnel started just above the river bed near the Town of Omitlán and about three miles to the east of Real del Monte. The tunnel, including branches, is 7½ miles long; and its outlet is approximately 1,000 feet below the point at which the water enters.

The task of driving this tunnel and of sinking the shafts was at that time a laborious one, as all drilling was done with hand steel; black powder was employed for blasting; and inflowing water hampered progress. Still, under the circumstances, good work was



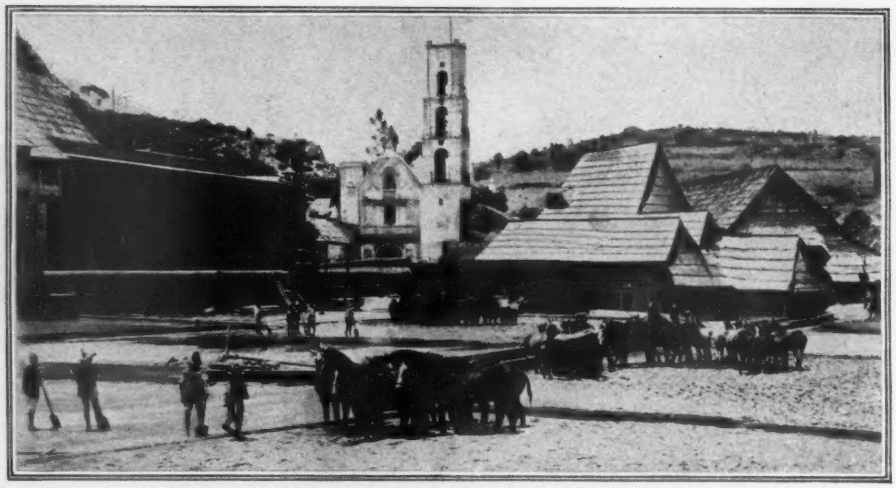




1—On the 492-foot level of the Xacal Mine. Miners using R-72 and N-75 drifters. 2—A 2-stage Cameron pump that raises 3,500 gallons a minute to an elevation of 328 feet in the Dos Carlos Mine. 3—Some of the big compressors on the property of the San Rafael Company at Pachuca. 4—Two 5-stage Cameron pumps direct connected to a single motor. These pumps in the Dos Carlos Mine handle 820 gallons a minute and lift the water 1,494 feet. 5—Cameron pumps in the Dos Carlos Mine that raise 3,000 gallons of water per minute, by six stages, to an elevation of 1,440 feet.

done; and the Aviadero Tunnel, as it was named, and some of its shafts are in use now.

The English company found the mines in a ruinous and deplorable condition; but after solving the drainage problem and unwatering the workings both in Pachuca and Real del Monte it was able to put them on a producing basis. Several of the shafts in the Real del Monte district were sunk to the 1,312-foot level or, as it was called, the Taylor Level. Today, this is the main haulage level for the mines in that district.



Hacienda de Regla, as it appeared in 1897 when the patio process was extensively used in treating the silver ores.

The company also built a well-equipped machine shop at Real del Monte, and this was operated under the supervision of experienced mechanics brought from England. Besides the machine shop, the surface plant included a foundry, a blacksmith shop, and a pattern-making department. Pumps, hoists, and other machinery from the mines and mills in Real del Monte and Pachuca were repaired in these shops, which were used until 1914 when most of the equipment was moved to a larger and more modern plant at Pachuca. This plant is being run by the present mine owners.

Notwithstanding the fact that the mines produced a large tonnage of silver ore during the years they were in the possession of the John Taylor Company, the cost of getting out the ore was also very high. The purchase of large quantities of machinery, and its transportation, installing, and operating, involved such heavy expenditures that the company was forced to go into liquidation after working the properties for 24 years—sustaining a loss of 10,000,000 pesos.

In 1850, the properties were sold to a local concern which, soon afterwards, opened up the famous bonanza at the Rosario Mine in Pachuca. This was a fabulously rich strike. In a year or so it yielded 30,000 tons of ore worth 10,000,000 pesos; and finds of specimens rich in native silver were common. The high-grade ore was bagged at the mines in canvas sacks for shipment. The Rosario is one of the oldest mines in the camp and, up to 1926, was a steady producer. In its early days this mine was drained by a Cornish pump at the San Nicolás Shaft. This was the first pump of its kind to be installed at Pachuca. Later the San Juan and the San Pedro shafts were sunk, and each was equipped with a larger pump of the same type.

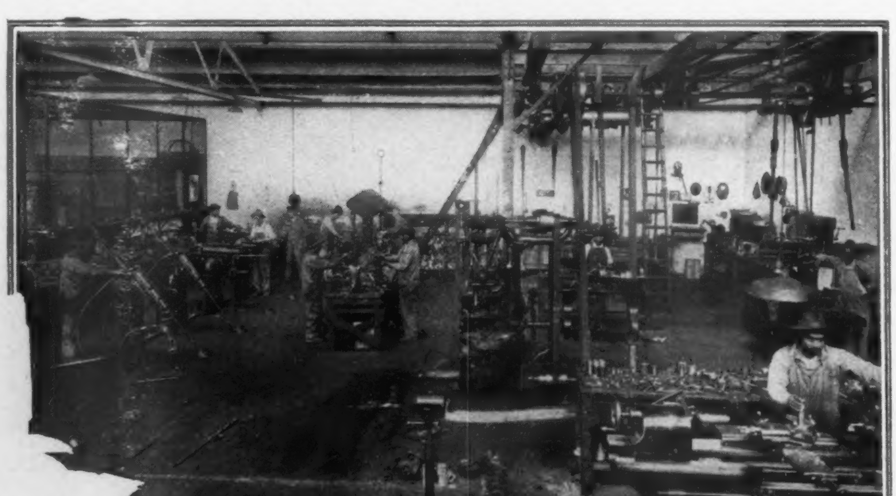
Rich ore bodies were next discovered in Real del Monte in the Santa Brígida vein at the Dolores Mine, also in the Santa Inés vein at the Dificultad and Carretera mines. Smaller but equally rich veins were opened up at the Resquicio, Cabrera, and Dolores mines.

As the workings increased in depth, more powerful pumping equipment was provided. The old pump at the Terreros Shaft was dismantled and the pump house converted into a fort for the housing of hundreds of convicts who were hired for a small sum of money from the government to labor in the mines. The company maintained a force of 200 armed guards, mostly cavalrymen, to watch the prisoners and to escort the silver bullion on its way from the mines to Mexico City and to Vera Cruz as well as the payrolls en route to the mines and mills. As an added protection against brigands, the bullion and the silver pesos were put in large, iron strong-boxes which were bolted to the wagons carrying them. These wagons, or *conducta*, were mule drawn, and some of them may still be seen on the streets in Real del Monte.

Often the guards were called upon to fight off bands of robbers in protecting company property, and to go into action in preserving order in the camp. They were a fine-looking body of men—well mounted, lavishly uniformed in silver-braided trousers, coats, and hats, and splendidly equipped with silver-ornamented saddles and other trappings. Señor Mello, who was the director of the company in 1855, was very proud of these men, and on occasions commanded them himself when going in pursuit of marauders. Señor Mello was of distinguished Spanish extraction; and it is told of him that he made frequent visits to the mines at night, disguised, rewarding the industrious with the gift of a small gold coin and punishing the slumbering with dismissal.

Up to that time, working conditions in the mines were very poor. Little attention was paid to hygiene, to adequate ventilation, and to accident-prevention. Few steam hoists were in use. Horse *malacates* and bullock hides did most of the work of hoisting the ore and the waste and of lowering materials. Few of the shafts were provided with skips; and cages were not introduced until some time afterwards. Most of the ore was packed to the shaft stations on men's backs and, in some of the smaller mines, even up to the surface by way of ladders. Wages were very low, a *barretero* or driller got from 75 centavos to one peso per day, and a *peon* received from 37 to 50 centavos per day, working 10-hour shifts. Then the lowest grade of ore handled contained around 800 grams of silver to the metric ton, hence the vast amount of pay ore and fills left in the mines and on the dumps. These were exploited by other companies formed subsequently to operate the mines in the Pachuca and Real del Monte districts.

All these companies used the patio process for treating ore. The Real del Monte Company treated most of the ore from their Pachuca mines in this way at Loreto; the San Rafael Company, at the Bar-



Drill-repair shop of the Real del Monte Company, Pachuca.

tolome de Medina Mill; the Guadalupe Fresnillo Company, at the Purísima Grande; the El Bordo y Anexas Company, at the Purísima Chica; the Maravillas y Anexas, at the Progreso and San Francisco mills; the Santa Gertrudis Company, at Guadalupe; and, later, the La Blanca and Santa Ana mines at the La Luz Mill. Hundreds of horses and mules were required in these mills to operate the *arrastres* or stone mills that crushed the ore, and to tread, in the *patios*, the ore mixed with quicksilver, sulphate of copper, salt, and water to form a thick slime.

It was a pitiful sight to see these creatures, their hoofs and fetlocks green from the copper sulphate. Various mechanical appliances were invented as a substitute for the animals in mixing the slimes, but none of these was satisfactory. The patio process was not only a costly but also an inefficient one—the silver recovery amounting only to about 75 per cent. Besides, the loss in quicksilver was great. Small fortunes in silver have been found in recent years in old *patios* and nearby creek bottoms. At Pachuca, all the tailings were emptied into the creek that runs through the town; and these have since been recovered and treated at a profit by the cyanide process.

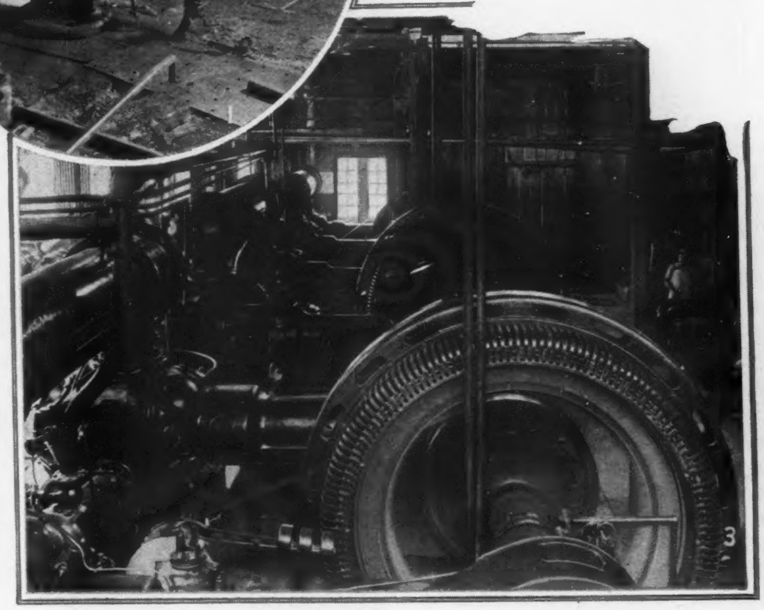
Large quantities of salt were required for this work, the Real del Monte Company, alone, using several thousand tons of it annually in its *patios*. Most of it was obtained from the states of Campeche and San Luis Potosi; but, later on, a plant was installed on the outskirts of Mexico for the recovery of salt from the lakes of Texoco.

The ore from the Real del Monte mines and that from the workings in Pachuca were treated in the early days of the districts in a number of mills or *haciendas de beneficio*. These mills were operated at different periods, and were variously situated close to the creek running below the Town of Real del Monte. They all made use of the water flowing thence from the outlet of the Aviadero drainage tunnel.

The first of these mills, of small capacity, was not long in use. It was located at San Juan Guerrero, where a chimney shaft was sunk by the Taylor Company for ventilating the Aviadero Tunnel. Today, this is the site of a big cyanide-process plant which was erected in 1905 for treating the ores from the Real del Monte district. This plant has a capacity of about 1,300 tons daily. At the outlet of the drainage tunnel was a mill that was abandoned many years before the mines were sold to their present owners. Another, which was in operation until 1905, was just on the outskirts of the Village of Omitlán. A fourth, at Velasco and about a mile from Omitlán, was formerly one of the most important of the old mills. There was located the country residence of the director of the Taylor Company. His house and garden are still standing; but the plant was shut down some time before the property was taken over by the people now running it. Still another *hacienda*, called Peñafiel, lies a little to the east of Velasco. This also was closed down years ago. Six miles from Velasco were two adjoining mills, the San Antonio and the San Miguel. With the exception of the San Antonio Mill, where the manganese silver ores were treated by roasting, all the others used the patio process.

The last in this list of old *haciendas* is at Regla, in a gorge, which is one of the scenic points of interest in the State of Hidalgo. There may be seen the famous Basalt Columns of Regla, also known as the Giant's Causeway of America, which stand close to 200 feet high. This mill was in operation until some time in 1905. The transportation of ores from the Pachuca and the Real del Monte districts was done by mule teams and by pack mules, some owned by the company and others by local freighters. In its heyday, when these scattered plants were working to capacity, the region roundabouts was a thriving one, and many small communities grew up around the mills. Some of these are now deserted and in ruin.

(*To be continued*)



1—Steel-sharpening shop of the San Rafael Company, Pachuca, equipped with three No. 50 sharpeners. 2—Workers equipped with S-49 "Jackhamers" in the Dolores Mine of the Real del Monte Company. 3—A group of PRE compressors at the Loreto Mine of the Real del Monte Company.

HANDLING ASHES BY SUCTION

An electro-pneumatic system for the removal of ashes from the basements of large buildings has been introduced recently in New York City. Aside from simplifying the work considerably it prevents the scattering of the ashes, which are at no time exposed to the atmosphere during their transfer from the cellar to the carrier on the street.

The equipment consists of an enclosed truck containing a capacious hopper fed by a tube connected to the permanent ash-handling system installed in the building. Suction is provided by a centrifugal compressor that is driven by a 40-hp. motor. The unit, as tried out recently in the financial district of New York removes the ashes at a velocity of 145 feet per second or, to put it in more understandable language, is capable of emptying a dozen standard ash cans in one minute.

The river which traverses the entire explored length of Howe Caverns and has at points the width of a sizable creek.

Well-built paths, flanked with guard rails, make it possible to reach all interesting points in the skillfully illuminated caverns.

Howe Caverns Made Accessible By a Deep Shaft

By DAN M. McNEIL

COMPRESSED air was recently put to effective use in connection with the sinking of a 156-foot elevator shaft at Howe Caverns, in the State of New York. A total of 3,400 tons of concrete, 105 tons of steel, and sixteen miles of wire and cable were required to complete the work.

In 1842, Lester Howe, a farmer, discovered the caverns that bear his name and which are said to rank among the largest in the world, with formations excelled by none. Located on the main line of the Delaware & Hudson Railroad, within 50 miles of Albany, Troy, or Schenectady, they attracted thousands of tourists in the days when electric illumination was unknown and their dark and eerie depths were penetrated only by the flickering light of torches. Since then the caverns have been closed to the public for nearly 50 years—in fact, were almost forgotten outside of the immediate locality until a young engineer at work in the vicinity, hearing the tales of the villagers, decided to investigate. His enthusiastic descriptions of the caves induced a group of capitalists to become interested in them and to take over their ownership. These men have spent a great deal of money in making them accessible and in providing every convenience and safety measure for tourists, including a spacious lodge at the surface with the appointments of a country club.

Westinghouse engineers devised a unique lighting system for the caverns, using 700 lamps for the purpose. Each of these is set in a concrete receptacle that blends so perfectly with the rocks that it can hardly be distinguished from them. The paths that trace their way for a distance of three miles through this subterranean wonderland have been leveled and widened.

The sinking of the elevator shaft was an achievement that called for the keenest judgment on the part of Mr. John L. Robertson, the contractor and a well-known mining engineer of Scranton, Penn. It was decided not to resort to the method usually employed in sinking a concrete caisson down to solid rock, lest the caisson get slightly out of plumb, but to timber the shaft progressively and to complete its sinking before placing any concrete. The wisdom of this course became evident when it was found that the bore hole had struck the edge of a rocky ledge, while the shaft was actually carried to bedrock lying 40 feet deeper.

A Nordberg-Butler air-operated shovel was used down to a depth of 35 feet to load the excavated clay and boulders into scale boxes, which were hoisted to the surface by a guy derrick. The use of this shovel was then abandoned on account of the heavy side pressure that necessitated the close bracing of the shaft timbering. This made it impossible to operate the shovel. It rained nearly every day the work was in progress; and the stickiness of the clay proved troublesome. A 6-inch bore hole served to draw the accumulating water 200 feet to the surface. This was done by placing a small air pump in the caverns and running a 1-inch air line down the bore hole to operate the pump and a $1\frac{1}{4}$-inch water line from the pump to the surface. Three 9x8-inch Ingersoll-Rand electric-driven compressors furnished the air for the rock

drills, clay diggers, steel sharpener, and pumps used on the job.

The concrete was run direct from the mixer by way of a vertical chute into a hopper, whence it was delivered to the forms by means of steel chutes. As the concreting was done during midwinter, the ingredients were heated just enough to keep them from freezing while on the surface. The temperature in the shaft was at no time lower than 45° F. Within the caverns the temperature remains constant—at 56° F. In sinking the shaft a much larger amount of rock was excavated than was actually required for the designed shaft, and the excess space was filled in solid with concrete so that the walls in some places are anywhere from 3 to 4 feet thick.

The architecturally attractive lodge that has been built over the entrance to Howe Caverns.

Two Otis electric elevators were installed. The entrance to the elevators is from a corridor opening off the main floor of the lodge. At the bottom, the passengers are discharged into a concrete tunnel leading into a well-lighted rotunda, from which the tour of the caverns, under guide service, begins.

Geologists assign an age of at least 1,000,000 years and probably more to the caverns. In that far-off day, a great arm or gulf of the sea extended as far inland as the present Great Lakes. In time, the chemical and erosive action of the water upon the rock gradually formed passages and chambers and sculptured a great variety of fantastic forms and features of great scenic charm. This process, eons after the sea retreated, was continued by rainfall. The hills in the vicinity are 1,500 feet high, and the surface waters rushing down the steep grades are collected and carried away by these underground channels. A stream which flows the entire known length of the caverns is at points as wide as a creek.

The limestones were originally marine deposits and contain imprints and shells of many of the lower forms of life, now extinct, which existed in the Silurian sea before there were any air-breathing or land animals. The limestone bed in which the caverns are situated is estimated to be eight miles thick. Ages later these rocks were buried beneath the sediments of the Devonian system—the line of demarcation being clearly visible within the caverns. The oldest passages lie high up in the limestone, and are now almost dry. In the course of ages they will be filled up by mineral deposits.

The roof at many points is studded with pencil-like stalactites each with a fresh deposit of lime at its tip, noticeable because of its whiteness, showing that the caverns are still undergoing change. An inch in a century is the probable rate of growth, although a stalactite in a Bermuda cave, which has been the subject of scientific measurement, develops only 1 inch in 250 years.

Possibly the leading attraction of Howe Caverns is a winding way, 550 feet long and from 3 to 6 feet wide, which doubles back and forth so that tourists walking single file cannot see the person directly ahead. This has been formed by erosion. There are numerous other interesting features, such as the Natural Bridge, the Inverted Village, the Grottoes of the Naiads, Dante's Inferno, the Leaning Tower of Pisa, the Home of the Fairies, and the Bell of Moscow which, geologists have told us, has been millions of years in the making. These are but a few of an endless variety of beautiful as well as grotesque forms sculptured through countless ages by the hand of Nature. Whether or not the Howe Caverns have been explored in their entirety, it is believed that they are 25 miles and more in extent. Four avenues that are now obstructed are to be opened up soon.

Photos, by J. A. Lenn

A striking formation that tells the mute story of the age-long action of dripping waters carrying lime in solution.

MOVABLE ELECTRIC FURNACE

A NEW type of electric furnace that can be shifted from base to base on the operating floor wherever there is work for it to be done has many fields of usefulness we are told and, at present, is limited in size only by the carrying capacity of cranes. Those built so far have ranged in size from small bell-shaped affairs of 3 tons to box-type furnaces with a capacity of 33 tons.

In a steel mill, for example, a single furnace of this kind may be employed to advantage in keeping several bases busy. To be explicit, steel to be heated is piled on the specially designed base, the furnace set on top by means of a crane, the electric leads plugged in, and the charge heated. When the steel is at the proper temperature, the furnace is lifted off and moved to another similar base that is loaded with a cold charge. Besides making the most effective use of the heat stored in the furnace walls, material handling is thus reduced to a minimum because the bases are conveniently set near the rolls.

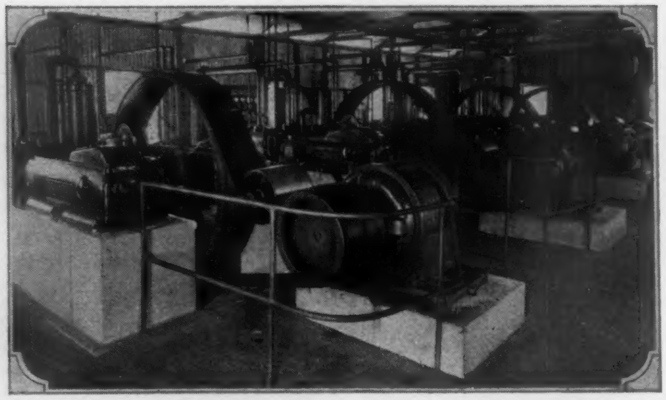
The largest electric furnace of this type for steel work is a 440-kw., 220-volt, 3-phase, 60-cycle unit which heats 66,000 pounds of sheet steel to 1,900° F. Without the base it weighs 20 tons and measures 14x9x11 feet. It has no doors, and is liquid sealed at the bottom. Scaling of the charge is prevented by filling the furnace with gas during the heating cycle. Two such furnaces of the 100-kw. bell type have been doing very satisfactory work in the hardening of steel by the exacting nitriding process—a new method of surface hardening by heating the steel in ammonia. The liquid seal insures excellent control of the ammonia gas, and electric heating gives the uniform and even temperature required. This new application of the electric furnace proves how readily it can be adapted to special needs.

Gas Jammers

By R. H. PENCE*

NOT so long ago the compressor was a stranger in the oil field. Times have changed since that day; and more and more the compressor is taking up old duties in a new way, and new duties never before contemplated.

Oil wells that were formerly pumped are now produced by the gas lift. Oil sands depleted of gas are given a new lease on life. Underground storage of summer gas for winter consumption gives dying gas fields a new importance. Distant cities are served from remote gas fields. Natural-gas gasoline plants supply gasoline with the necessary kick for the modern automobile. And so the list goes on, with new ones yet to be added. The compressors that have played the most important part in this advance have been the best obtainable; and the oil-and-gas industry looks more and more to compressor manufacturers for improved methods of application and for machines capable of performing not only the present but still wider duties in the future.



A battery of compressors supplying the pumping medium used in operating gas lifts in neighboring oil wells.

Where gas lift is employed, the conditions under which compressors operate are many and varied. In some cases large capacity is needed with a low pressure: in others, small capacity with extremely high pressure is desired. Between these two extremes are problems galore in compressor design. Never do two wells operate under the same pressure; and since the compressor investment is often not intended for a single well, a machine may be called upon to operate at varying pressures. One large maker has taken care of this by the use of built-in clearance pockets which permit a compressor to meet differing demands while utilizing most efficiently the driving power available.

Where high pressures are encountered—in some instances approaching 2,000 pounds, third-staging of the compressed gas is necessary. This has usually been done by supplementing a 2-stage compressor with a single-stage, high-pressure, small compressor. In many cases it has fallen to the lot of compressor engineers to suggest designs of coolers, scrubbers, and kindred equipment for these duties. In fact, the service they have rendered has been responsible for the tremendous increase in petroleum displacement achieved with compressors in the oil fields. Problems have been many in this special service.

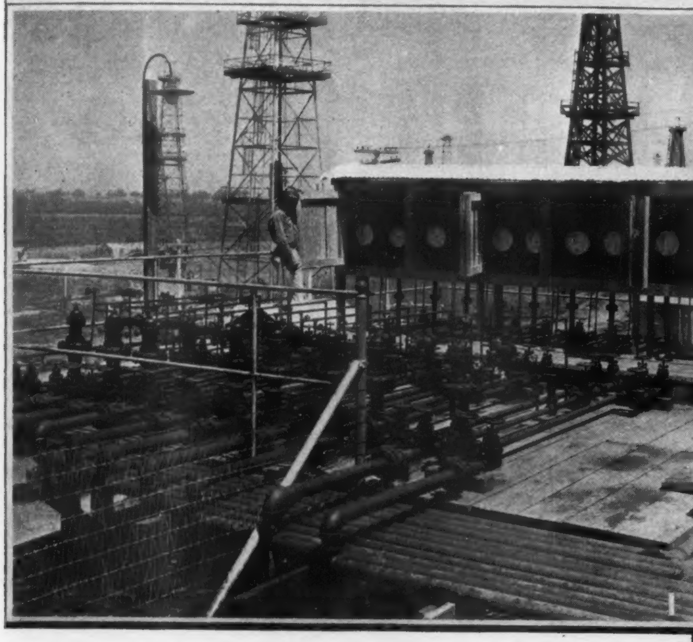
New types of cylinders, valves, rings, packing, etc., have had to be designed and proved. Compressors have had to be built for the particular work in hand—small, rigid, semi-portable machines for use in flush oil fields, and large, slow-moving, heavy machines for semi-permanent installations. The determination of the kind of power that would drive them in the most economical manner, commensurate with the conditions imposed, has been a problem. Direct-connected, steam-driven compressors have been found useful in some flush oil fields; in others the electric, belt-driven machine has been preferable; and in still other cases the gas-engine, direct-connected or the gas-engine, belt-driven compressor has proved most satisfactory. In old oil fields, where gas has become a rarity, oil engines have been effectually employed both for direct-driven and belt-driven machines.

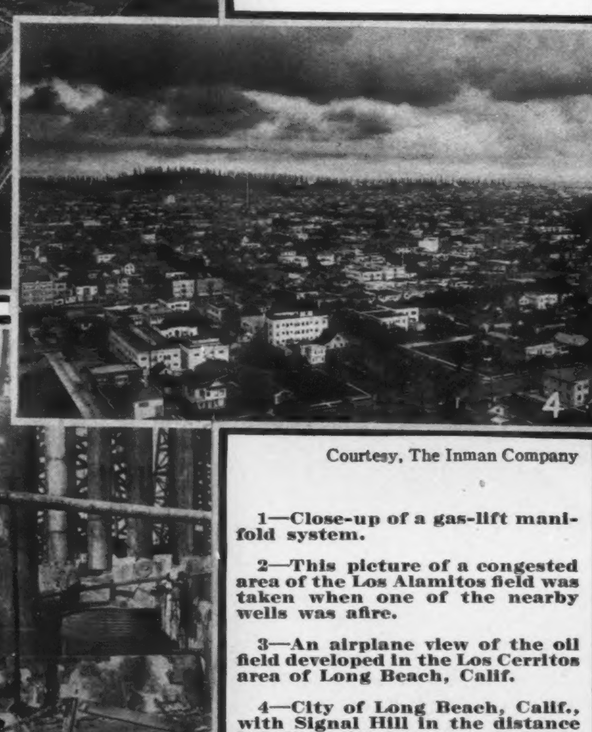
Every compressor installation presents new problems; and much of the success attending such an installation is attributable, in the first place, to the proper choice of equipment, and, then, to the carrying out of the recommendations of the manufacturer's engineers.

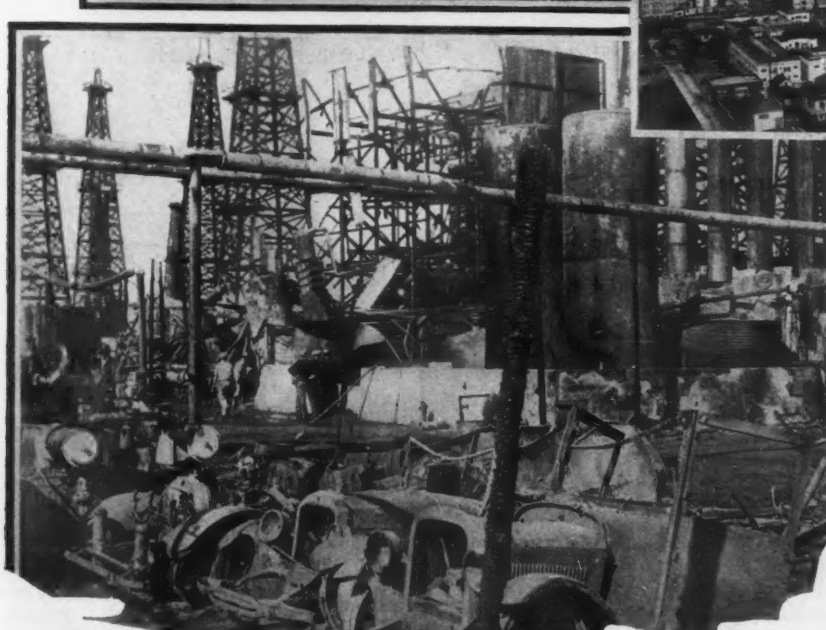
*Signal Engineering Co., Long Beach, Calif.

Courtesy, The Inman Company

Flood lights, mounted on towering derricks, make it possible at Signal Hill to carry on work at an unimpeded rate of production during the hours of darkness.







Courtesy, The Inman Company

1—Close-up of a gas-lift manifold system.

2—This picture of a congested area of the Los Alamitos field was taken when one of the nearby wells was afire.

3—An airplane view of the oil field developed in the Los Cerritos area of Long Beach, Calif.

4—City of Long Beach, Calif., with Signal Hill in the distance bristling with its array of closely placed derricks.]

5—A small measure of carelessness caused the fire that spread all this havoc in an area marked by congested drilling.

Mount Carmel-Zion National Park Highway

This New Road, Twenty-Five Miles Long, Will Prove a Boon to Motorists Visiting This Scenic Section of Utah

By R. G. SKERRETT

This picture shows plainly the impressively rugged nature of the mountain country within Zion National Park.

ZION National Park, Bryce Canyon National Park, and Cedar Breaks lie in the scenic wonderland of southwestern Utah. Each of these reservations is noted for its gorgeous coloring and for the unusual rock formations that have been modeled in the course of ages by the combined actions of wind, water, and temperature changes.

Situated as these points of attraction are within relatively short distances of one another, the geological characteristics are fundamentally the same although time has wrought somewhat differently in producing the physical beauties of each. In a sense the variations are matters of form and magnitude but fairly similar in the vividness of the hues that make an adequate word picture of them quite impossible.

We take as typical of much that is common to the three parks the following description contained in a pamphlet issued by the National Park Service. "A 'Yosemite Valley done in oils' comes close to a description of the principal features of Zion National Park. This gorgeous valley has about the same dimensions as the famous Yosemite Valley. Extraordinary as are the sandstone forms, the color is what most amazes. The deep red of the Vermilion Cliff is the prevailing tint. Two-thirds the way up these marvelous walls and temples are painted gorgeous reds; then, above the reds, they rise in startling white. Sometimes the white is surmounted by a cap of vivid red, remains of another red stratum which once overlay all. The other colors are many and brilliant. The Vermilion Cliff rests upon 350 feet of even a more insistent red relieved by mauve and purple shale. That, in turn, rests upon 100 feet of other variegating strata. Through these successive layers of sands and shales and limestones, colored like a Roman sash, glowing in the sun like a rainbow, the Mukumtuweap River has cut its amazing valley." This is only one of a number of the bewilderingly beautiful features of Zion National Park.

From the same source we draw this abridged description of Bryce Canyon National Park: "In reality Bryce is not a canyon, rather it is a great horseshoe-shaped bowl or amphitheater cut by erosion into the Paunsaugunt Plateau and extending down a thousand feet through its pink and white sandstones. Words can never convey an adequate conception of the fantasy and beauty of Bryce Canyon. It must be seen to be completely realized. From the countless variety of forms in the canyon it would seem that the imagination of some titanic sculptor had run riot and cut into the soft sandstone every figure and shape known to or dreamed of by men. Domes, spires, and temples predominate, decorated in all the colors of the spectrum but with reds, pinks, and creams predominating."

We are told that Cedar Canyon is a great amphitheater, called Cedar Breaks, covering approximately 60 square miles. This is in reality a series of amphitheaters, eroded to a depth of 2,000 feet in the Pink Cliff formation at the summit of the plateau. The forested rim of the Breaks attains an altitude of 10,400 feet. The principal charm of this area lies in its blazing color. The cliffs are white or orange at the top, breaking into tints of deep rose and coral in the huge bowl, which displays an innumerable array of unique erosional formations.

So much by way of explanation of why this section of Utah draws to it annually thousands of sight-seeing tourists from all parts of the country; and now for an outline of what has been done recently by State and Federal authorities to make these amazing creations

Photos furnished by National Park Service

Left—Looking westward on the Mt. Carmel-Zion National Park Highway toward the famous Streaked Wall. Right—One of the numerous switchbacks on the new scenic highway with the Great Arch of Zion in the background.

1—Looking into Pine Creek Canyon from the top of the Great Arch of Zion, with winding sections of the new highway in the middle distance.

2—A close-up of one of the switchbacks on the Mt. Carmel-Zion National Park Highway by which the mountainsides can be negotiated on a comparatively easy gradient.

3—From this position on the new highway one gets a splendid view of the West Temple.

4—Although this section of the new highway necessitated the blasting of much rock, the utmost care was exercised in preserving unharmed any of the features of the natural setting.

The west portal of the tunnel is where the upper section of the last switchback terminates abruptly near the center of the picture. Beyond, to the left, can be seen the slides of excavated rock dumped from the first of the galleries.

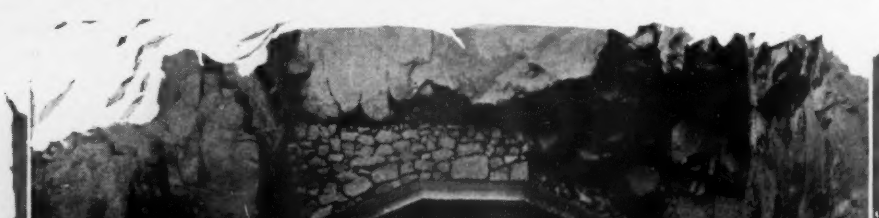
more readily accessible to the traveling nature lover and to students of geology bent upon reading the mute story of the dim past of this continent upon which we dwell.

Heretofore, Cedar City, Utah, has constituted the single point at railhead from which the three parks could be reached over good roads. That is to say, the three parks were accessible by a circling route that invariably brought the traveler back to Cedar City. This had its disadvantages or inconveniences. Therefore, in order to reduce the distances to be traveled between the parks as far as practicable and to shorten the trip to the Grand Canyon, it was decided to provide a link between Zion National Park and Mt. Carmel to the east of that reservation—Mt. Carmel being on a modern and well-developed highway running nearly due south from Salt Lake City to the Grand Canyon National Park. This cut-off, now completed, has a length of approximately 25 miles and extends from Springdale to Mt. Carmel. In this way, the distance to Bryce Canyon is reduced from 159 miles to 88 miles, while the run to Cedar Breaks is cut to one-half its former length of 140 miles. Incidentally, the distance to the Grand Canyon to the south, in Arizona, becomes 100 miles—shorter than heretofore by 42 miles. It should be understood that this new link in the highway system of Utah will be a great convenience to tourists visiting the parks mentioned by means of automobiles, while offering alternative routes to the sightseer. Part of the new road within the park supplants a previous road that had a gradient as great as 25 per cent in some sections.

Some one will ask: "Why, with paralleling highways extending down into southwestern Utah should travel have been so long hampered by a scarcity of east-and-west improved roads?" The answer is that the rugged heights of an offshoot of the Wasatch Mountains lies between the flanking north and south highways, and there has existed but a single road through one pass in the range that could be kept open the year round. This pass is situated 150 miles above the southern border of the State. Just north of Zion National Park the mountains tower abruptly to a height of 10,000 feet or so; and a road cannot be kept passable the year through in that section of the United States unless it lies below an elevation of 8,000 feet. This state of affairs complicated the problem of finding a permissible route eastward from Zion National Park; and much difficult preliminary survey work had to be done to establish a course that could be followed, without prohibitive outlay, in building a road from the park eastward to the highway upon which the Village of Mt. Carmel lies.

The task of ascertaining the best location for the projected route was made all the more difficult because no maps of the country were available; and there were sections of the territory to be traversed that were known only to one or two men. This was particularly true of Upper Pine Creek Canyon. The primary problem consisted of discovering a practicable route that would begin on the floor of the valley, at an elevation of 4,100 feet above the sea, and climb thence to an elevation of 4,900 feet. Therefore, it was necessary first to explore the region and to make surveys from which a map of approximate accuracy could be drawn; and then, with this as a base of action, the next thing was to plan carefully the course to be followed by the road in contemplation. After deciding upon what seemed to be the likeliest line for the road, then the route had to be surveyed with sufficient accuracy to permit reasonably close estimates of the work to be done by the actual builders. This job entailed weeks of strenuous and even hazardous activity on the part of the surveyors. They had to make their way through dense undergrowth, to climb precipitous rocky slopes, and in one instance the men were able to get up and down the face of a cliff 300 feet high only by means of a rope. In the end, it became evident that the route by way of Pine Creek rather than up the valley of the Virgin River would cost less to construct and would, at the same time, make accessible the upper regions of Zion National Park.

The surveys were started in 1925; but it was not until 1927 that al arrangements were made and the work of building was begun. The highway has a total length of 25 miles—$8\frac{1}{2}$ miles of it being within the limits of Zion National Park and the remaining $16\frac{1}{2}$ miles linking the park on the east with U. S. High-



West portal of the tunnel driven through the mountainside above Pine Creek Canyon. Note the timbering used to reinforce the insecure sandstone.

way No. 89 at a point just south of Mt. Carmel. The part of the undertaking that lies within the park has been covered by national-park road funds, and the section east of the park has been built as a Federal Aid road project—Utah paying 26 per cent and the Governmen 74 per cent . With the completion of two bridges, yet to be built, the entire development will involve a total outlay of $2,023,000.

The new highway starts at the junction of Deep Canyon and Pine Creek Canyon, and for three miles it mounts steadily to a point 3,000 feet higher whence the route climbs 800 feet up the steep slope from Pine Creek by a series of five switchbacks—sections of which are visible in some of the accompanying illustrations. At the eastern terminal of the last switchback the road enters a tunnel, 5,607 feet long, that was driven just inside the face of the mountain that slopes too steeply to permit the cutting of a shelf-like roadway. This tunnel has a height of 16 feet and a width of 22 feet, and was driven through sandstone. The rock when exposed to the air showed a pronounced tendency to flake; and because of this it was deemed advisable not only to timber 650 feet of the tunnel but also to reinforce sections of the exposed surfaces with concrete to arrest further disintegration.

One of the series of galleries on the outer side of the tunnel. From these points of vantage can be viewed some of the scenic wonders of that section of Zion National Park.

The location chosen for the tunnel was largely dictated by a desire to insure easy curves and also to obtain relatively short distances between the openings or galleries that occur at five points in the length of the tunnel. These openings offer vistas of the scenic wonders of the route and, incidentally, admit daylight to the tunnel and promote a free circulation of the air so necessary in getting rid of the exhaust gases of motor vehicles. The prime purpose of these openings was to give the tunnel drivers additional points of attack from which to advance headings in two directions. The locations of these galleries were established by triangulation from lower levels on the opposite side of the steep canyon. It was impossible to run the survey by lines actually measured on the face of the cliff to be pierced. The drill runners, engaged in excavating the gallery openings between the east and the west portal, did their work from sturdy scaffolds either suspended from the top of the cliff or held up by trusses resting upon fortuitous footings offered by projecting ledges in the irregular face of the cliff. The intervals between the gallery openings vary in length from 300 to 1,200 feet, and the galleries, themselves, have openings ranging from 60 to 120 feet in length, depending upon the conformation of the surface of the cliff at the several stations. The excavated rock was dumped into the valley or on to the mountainside from these openings, thus simplifying the task of disposal.

This winding road, with its series of switchbacks, climbs from the bottom of Pine Creek Canyon to a point 800 feet higher where it meets the west portal of the tunnel. The road is about five miles long; but an air line between its two ends is a distance of only one mile.

We can get a better idea of the nature of the task confronting the Nevada Contracting Company if we bear in mind that the contractor had to build a pioneer road three miles long on the switchback section in order to get certain of his equipment in position to start work; and all his machinery was hauled from railhead, at Cedar City, 65 miles away. Even after his apparatus was deposited in Pine Creek Valley the contractor had to get it up to the western portal of the tunnel, 800 feet above the floor of the valley. This he accomplished by constructing a cableway 1,200 feet long; and up this sharply pitched cable he hoisted his supplies and machinery—a single mechanical part weighing as much as 3,000 pounds. By means of this cableway the contractor lifted, to their different working positions, compressors, rock drills, and various other essential equipment utilized in putting the tunnel through in record time.

The procedure employed consisted of first driving a pilot tunnel 8x10 feet in cross section, and afterwards resorting to ring drilling in enlarging the tunnel to full size. The rate of advance was greatly aided by the softness of the sandstone pierced. Mucking in the

pioneer-tunnel sections was done with Nordberg-Butler mucking machines; and during enlargement operations the blasted rock was handled by a Bucyrus-Erie shovel. The tunnel rises on a 5 per cent grade from west to east and is, therefore, nearly 300 feet higher at the east portal than it is at the west portal. Manifestly, this gradient would impose heavy wear upon the roadbed, especially when cars are climbing; and, to offset the sandstone's deficient resistance to traffic abrasion, the engineers prescribed a concrete pavement within the tunnel. Outside the tunnel the highway will be finished with a mixed asphaltic-gravel surface.

The Nevada Contracting Company started operations on October 20, 1927; by September 20 the year following the pioneer tunnel was holed through; and one month later the enlargement work was completed. On January 1, 1929, the tunnel was virtually finished and ready for service. In grading the switchback approach west of the tunnel the contractor was obliged to excavate 300,000 cubic yards of earth, disintegrated sandstone, and large blocks of rock, and also to handle 460,000 station-yards of overhaul. The contract specified the excavating of 3,000 cubic yards of solid rock within the section adjacent to the tunnel in addition to the 75,000 cubic yards excavated within the tunnel. Contracts covering grading of and structures for the highway section between the east entrance to Zion National Park and Mt. Carmel—a matter of 16½ miles—were awarded to the Reynolds Ely Company and to the Raleigh-Lang Company.

The National Park Service plans to formally dedicate the great project on June 1, 1930; and the Director of the National Park Service, in referring to the undertaking in his last annual report, makes special and complimentary mention of the way in which the contractors pushed forward with their work when funds were not available in the National Treasury because of congressional delay in passing the necessary deficiency bill.

The completion of the Mt. Carmel-Zion Highway will unquestionably draw to the region many thousands of tourists and sightseers that would otherwise not visit the parks if obliged to confine themselves to the roads hitherto available. From now on the motorist will have at his disposal alternative routes; and from Zion National Park he may go to Mt. Carmel and thence northward to Bryce Canyon and Cedar Breaks and onward to Salt Lake City, if he so desire, or he may turn southward for a trip to the north rim of the Grand Canyon National Park. No matter which course he elects to pursue he will have within easy reach scenic wonders of great magnitude and of outstanding beauty and impressiveness.

An EU hoist mounted for handiness on a small 4-wheel car and used in unloading zinc tailings at the Sullivan zinc smelter in Kellogg, Idaho. This air-operated hoist, pulling a scraper, makes it possible to unload a 50-ton car in the course of only an hour and a half.

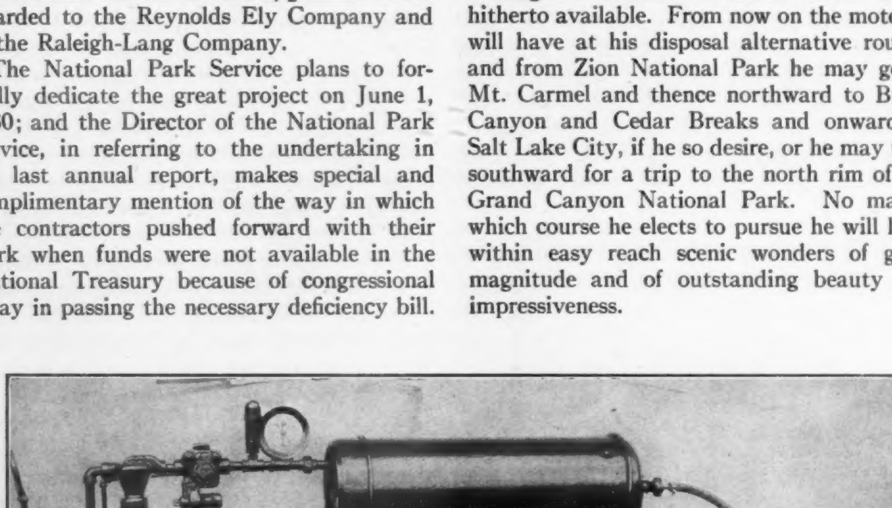
IMPROVED BLASTING MACHINE

An improvement in 1- to 50-hole blasting machines has been announced by the Hercules Powder Company. The new feature consists of an armature shaft of special porous bronze impregnated with graphite that is said to do away with the need of oiling the bearings. During assembly a little oil is put on this shaft, and, thereafter, throughout the life of the blasting machine, the shaft bearing is self-lubricating. Troublesome oil cups have thus been eliminated; and the only part that now has to be lubricated in the ordinary way is the rack bar.

PORTABLE TIRE INFLATER

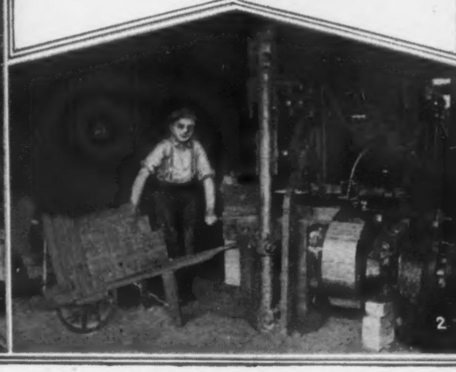
This portable tire inflater is the product of the Department of Street Railways of the City of Detroit, Mich. Influenced by the need of something of the sort that would facilitate the charging of tires in its garages, heads were put together, with the result as here illustrated.

Bolted onto the low, 4-wheel truck is a 21-cubic-foot air receiver built to carry a pressure of 300 pounds per square inch. By means of a reducing valve the high-pressure air is stepped down to 140 pounds before it is admitted to the smaller tank, on top, whence it is fed to the tires by way of the flexible hose connection. And that the operator may at all times have a visible index of the pressure in each container, an air-gage with two indicators is interposed in the line. The large receiver is charged in the department's car house, adjoining the garages, which is equipped to supply the necessary high-pressure air. One man can easily pull the inflater from point to point in the garages wherever trucks and cars whose tires need air may be standing.



Courtesy, Electric Railway Journal

The portable tire inflater conceived and built by the Detroit Department of Street Railways for use in its garages.



1—Pneumatic clay diggers at work in the pit.
2—This machine is capable of turning out 1,200 bricks an hour.
3—Four clay diggers of this type do the work previously performed by six men and with the use weekly of 40 pounds of high explosive.

Pneumatic Diggers Get Out Clay For Brick-Making

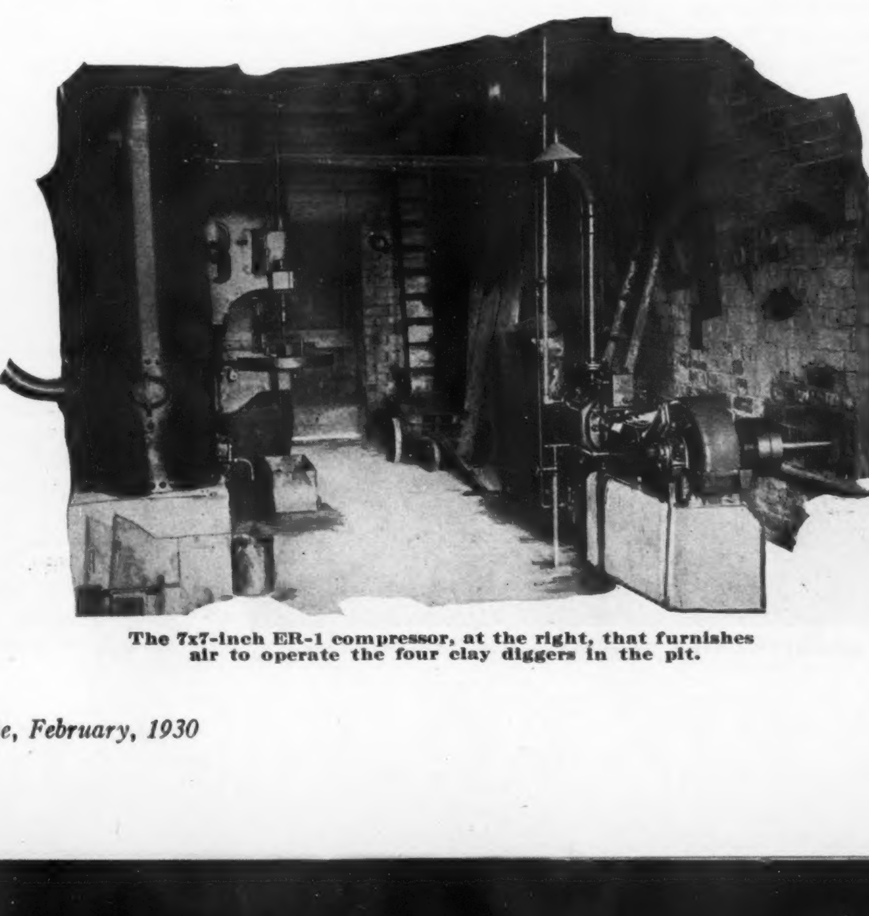
FOR decades the name of Cocking has been identified with brick-making in England. In this we have another outstanding example of a practice in British industry of handing down from father to son a business in which success has been won through the continued excellence of the commodity manufactured.

The art of making bricks in England dates back to the days when Britain was held by the Romans; and while there was a period of some centuries following the withdrawal of the Romans during which burnt bricks ceased to be made, there came a time in the thirteenth century when the industry was revived. The devastating fire that swept London in 1666—wiping out thousands of structures fashioned largely of timber—emphasized the advantages of brickwork; and from that distant day to the present bricks have been used in ever increasing quantities for structural purposes wherever stone was not available for architectural purposes. These facts are mentioned merely that we may know something of the antiquity of the industry with which the house of Cocking has been identified for a long while.

At Doncaster, in Yorkshire, Messrs. Cocking & Sons, Ltd., are operating a plant that was organized by Messrs. F. W. Cocking and G. E. Cocking in 1893. Mr. G. E. Cocking at that time owned and was working an old-established plant at Walkeringham, near Gainsborough, England. The old plant was run under the trade name of Cocking & Sons. The plant at Doncaster started with two semi-plastic brick-making machines and with one 14-chamber continuous kiln. So outfitted it was capable of turning out 100,000 bricks weekly. Fifteen years later, that is in 1908, the company was reorganized under the title of Cocking & Sons, Ltd.; and contemporaneous with this change a new 16-chamber kiln was built and two more brick-making machines were added to the equipment. With these amplifications, the capacity of the Doncaster plant was increased to 200,000 bricks a week.

At Doncaster, the raw material used in making the bricks is what is known as boulder clay, which is of an extremely tenacious nature and ordinarily entails much laborious work in getting it out of the deposits formed ages and ages ago. Until recently, the clay was excavated with picks and steel bars, with the added help of a measurable quantity of high explosive. By the present procedure air-driven clay diggers are utilized instead of picks and bars, and this also obviates the use of any explosive.

Since Cocking & Sons, Ltd., adopted pneumatic diggers of the No. 157 size, the company has been able to do with four men and four of these diggers what used to require the labors of six men besides a weekly expenditure of 40 pounds of explosive that cost as much as the wages of an extra man. The use of the explosive was necessary to break loose the tough clay which is now being excavated readily and rapidly with the pneumatic diggers. These tools have extension handles that permit the operator to stand upright when at work. In brief, the equipment has reduced the previous cost of getting out the clay by fully 33 per cent. The air needed to oper-



The 7x7-inch ER-1 compressor, at the right, that furnishes air to operate the four clay diggers in the pit.

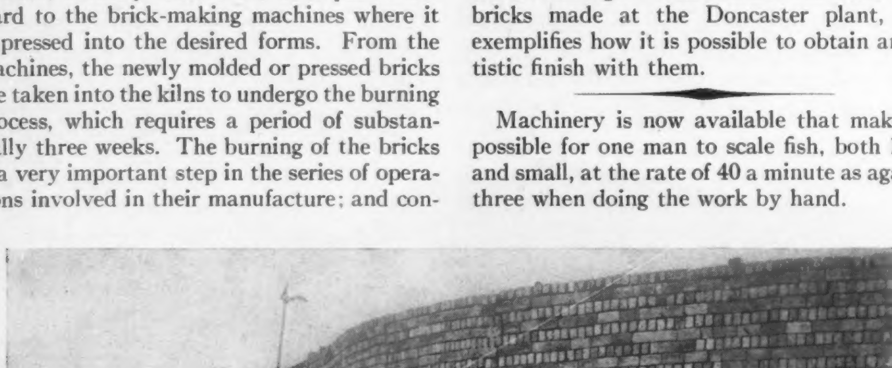
This house was built exclusively with bricks from the Doncaster plant of Messrs. Cocking & Sons, Ltd.

ate the four pneumatic diggers in the pit is furnished by a 7x7-inch ER-1 Ingersoll-Rand compressor which is belt driven from a main-line shaft by means of an extended shaft on the machine. The compressor is of a very recent type, and is admirably suited for service where the load varies more or less continuously during the working hours.

From the pit, the clay is moved to the factory by means of an endless chain tramway; and in the factory it is ground by machinery in a pit. The clay is then elevated to the screening room where it comes from the screens in the form of a fine powder. This powder, suitably moistened, next passes onward to the brick-making machines where it is pressed into the desired forms. From the machines, the newly molded or pressed bricks are taken into the kilns to undergo the burning process, which requires a period of substantially three weeks. The burning of the bricks is a very important step in the series of operations involved in their manufacture; and considerable care and a nice regulation of the temperatures in the kilns are necessary in order to insure a thoroughly satisfactory product.

It is interesting to note that although the Cockings have been so long in the business of making bricks they are not hampered by conservatism but are ready to make use of the latest mechanical aids that will enable them to reduce operating costs and to increase output without any sacrifice in the quality of the product. In this connection, attention is called to one of the accompanying illustrations which shows the home of the work's manager. That house was built with bricks made at the Doncaster plant, and exemplifies how it is possible to obtain an artistic finish with them.

Machinery is now available that makes it possible for one man to scale fish, both large and small, at the rate of 40 a minute as against three when doing the work by hand.



One of the two brick kilns at Doncaster. It has a capacity of 270,000 bricks.

MAKING MUSIC VISIBLE

MUSIC can now be seen as well as heard, owing to a newer form of the osiso—a sensitive electrical instrument that is being used, among other things, in studying the behavior of radio waves and in instructing the totally deaf to speak properly. The projection osiso, which makes music visible, is the product of C. Anderson, engineer of the Westinghouse Electric & Manufacturing Company, and of William B. White, acoustic engineer of the American Steel & Wire Company.

The device is used in conjunction with a microphone, and consists essentially of a delicately suspended mirror that is oscillated in unison with the received sound waves. A beam of light focused on this mirror is reflected by it toward a series of revolving mirrors which, in turn, project it upon a screen. When all is quiet, a long white line is seen upon the screen; but the instant a sound reaches the microphone the line is thrown into waves much as though one end of it had been taken hold of and shaken. The extent of these waves varies with the sound, and may range all the way from gentle ripples, produced by low tones, to the most intricate peaks and valleys representing loud and complex tones.

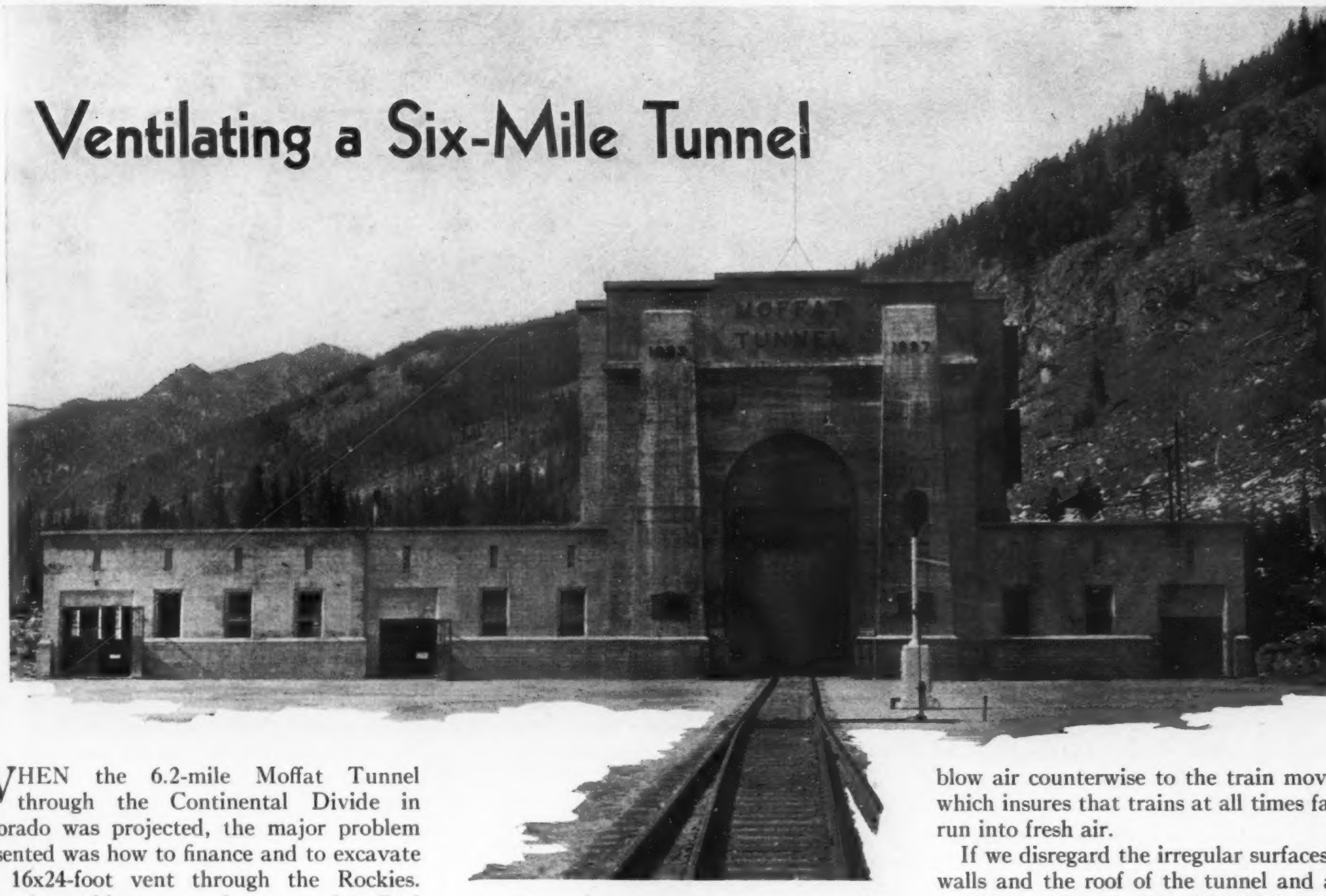
And what advantage is there in thus translating the sounds made by a singer or a musical instrument? According to Mr. White, by the use of the projection osiso—that is, with the eye to aid the ear—it will be possible to still further improve the wire for musical instruments, as well as the instruments themselves. To the student of music it should be of considerable assistance. Not only can their mistakes be made visible and their shortcomings more readily pointed out to them, but they can improve their technique by contrasting their own wave patterns of certain compositions with those made by distinguished artists.

VEHICULAR TUNNEL PLANNED UNDER TAMPA BAY

POINTS on opposite shores of Tampa Bay, Fla., are to be put within easy reach of one another by a vehicular tunnel provided the plans, which are now in the hands of the Federal authorities, are approved by that body. The scheme is an ambitious one and proposes to connect Pinellas, at the tip of the peninsula lying to the west of Tampa Bay, with Piney Point on the mainland—a stretch of more than seven miles—by 4,155 feet of concrete tunnel, 12,362 feet of causeway, and 20,848 feet of concrete trestle. In design the tunnel is similar to the one now operating between Oakland and Alameda in California. Estimates place the cost of the entire undertaking at $6,500,000.

This great project would form a direct link between the Gulf Coast Highway and the Tamiami Trail and shorten the run between St. Petersburg and points in southern Florida by 42 miles. A survey made by competent engineers places the potential traffic through the tunnel at 550,000 cars per annum.

Ventilating a Six-Mile Tunnel



By C. H. VIVIAN

WHEN the 6.2-mile Moffat Tunnel through the Continental Divide in Colorado was projected, the major problem presented was how to finance and to excavate the 16x24-foot vent through the Rockies. How these things were done was described in this Magazine as the work progressed. To jog the memory of the reader, let it be recalled that an improvement district was created by legislative act and bonds were voted. Representing the taxpayers of the district, who thereby furnished the $18,000,000 that the tunnel cost, was a commission of five men, appointed by the governor. This commission had general charge of the undertaking, and negotiated the contract under which the firm of Hitchcock & Tinkler carried on the actual work.

The tunnel was driven to shorten the line of the Denver & Salt Lake Railway, which extends from Denver westward to Craig, Colo., a distance of 232 rail miles. It eliminates 23 miles of line formerly required to cross Rollins Pass at 11,660 feet—reputed to be the greatest altitude ever reached by a standard-gage railroad. It reduces the maximum grade from 4 per cent to 2 per cent, and does away with approximately half the curvature of the entire railway.

While construction work was underway, the railway company was concerning itself with the problem of how it would operate trains through the tunnel after its completion. It was evident that with the tunnel open to the air at only its two ends, artificial ventilation would have to be provided to clear the passage of smoke and gases if steam locomotives were employed. The alternative was to electrify the line through the tunnel.

Both plans were considered at length and in detail. It was found that ventilation would cost much less than electrification. On the other hand, there was doubt in some minds, notably in those of the commission members, that it would be possible to satisfactorily ventilate a tunnel of such length.

There was little in the way of precedent to refer to in this country, so Mr. W. R. Freeman, president of the railway company, visited and studied the principal tunnels of Europe. There he found longer tunnels than the Moffat Tunnel being adequately ventilated. Accordingly, it was decided to install artificial ventilation for the Moffat bore. None of the systems in use abroad was entirely adaptable to the conditions, so Mr. Freeman and his staff of engineers set about designing a plant that would meet their needs.

The tunnel was opened to traffic in February, 1928. From the first, the ventilation was accomplished successfully. After the thorough test that the system has now had under actual operating conditions, it is almost superfluous to state that the installed plant is entirely suited to the work and that the judgment of those responsible for it has been fully vindicated.

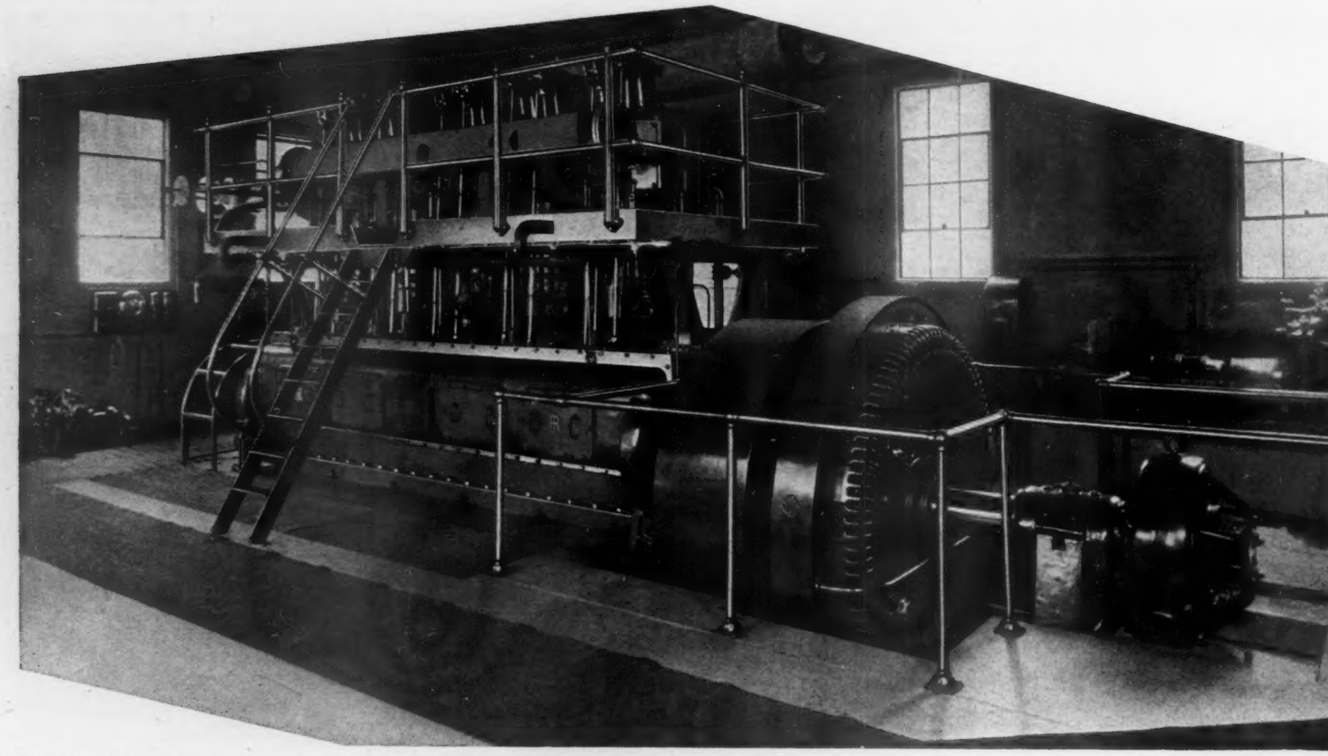
Ventilation is effected by changing the air within the tunnel by means of electrically driven fans. Only one fan is operated at a time, but two are installed to provide a standby unit. A distinctive feature that is found in no other installation of comparable size is the capability to move the air in either direction. This makes it possible always to blow air counterwise to the train movement, which insures that trains at all times face and run into fresh air.

If we disregard the irregular surfaces of the walls and the roof of the tunnel and assume a uniform cross section of 16x24 feet, we can compute the total air space within it to be 12,570,624 cubic feet. Since the fan has a capacity of 350,000 cubic feet per minute, the theoretical time required to change the tunnel air is about 36 minutes. As a matter of fact, the air stream flows faster in the center than at the sides, particularly because there are numerous impeding side and roof projections in the form of timbers and rock faces. The high efficiency of the system is shown by the fact that operating the fan for 40 minutes after a train has passed through will clear the tunnel of all except traces of smoke.

Just prior to the opening of the tunnel, when tests were being conducted, work trains pulled by large Mallet locomotives were employed daily within the bore while 200 men were engaged laying track. The men did not suffer the slightest ill effects from smoke or gases. Other exhaustive tests were made; and in every case the engineers, using delicate instruments, were unable to detect harmful gases in the tunnel after the blowing period.

The high point in the tunnel is near the center. The grade from West Portal to the apex is eight-tenths of 1 per cent, while that from East Portal to the apex is only three-tenths of 1 per cent. Moreover, most of the freight movement is from west to east, or toward Denver. Naturally then, because of the harder pull and the heavier load, a train moving from west to east will emit more smoke than one running from east to west. Two locomotives are sometimes required on the west-to-east run.

However, while the volume of smoke and



The 5-cylinder, Type PR oil engine, direct connected to a 400-kw. generator and its exciter. This unit furnishes the power to operate the motor-driven ventilating equipment.

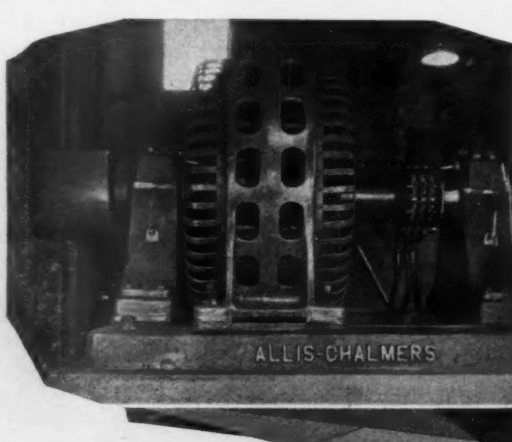
gases exhausted varies with the direction of the train movement, the fact that the air within the tunnel can be completely changed in approximately 40 minutes after a train has passed through makes it unnecessary to operate the fan for a longer period under ordinary conditions. To this normal blowing period must be added the time taken by the train to pass through, since the fan is started as soon as a train enters the bore.

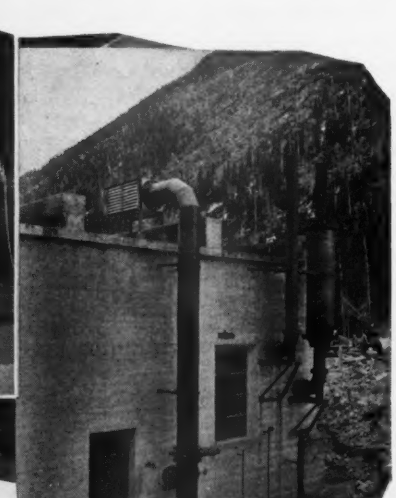
The ventilating plant is notable for its economy and its ease of operation. Such a system of electrical control has been provided that the operator has little more to do than press a few buttons to start or to stop the plant. All the equipment is concentrated at East Portal, which is 50 railroad miles west of Denver and at an elevation of 9,198 feet. The fan normally used is driven by a 500-hp. motor and creates an eight-mile-an-hour wind. The standby fan is larger, being provided against the time when traffic through the tunnel will be heavier. It is operated by a 750-hp. motor, and is capable of putting 450,000 cubic feet of air per minute through the tunnel at a velocity of fourteen miles per hour.

While blowing is in progress, a heavy canvas curtain is lowered over the eastern entrance to the tunnel. It is motor controlled and, when down, automatically starts the fan. Automatic devices guard against a train running through this curtain. Outside the tunnel 1,500 feet, and at a similar distance inside, are positive blocks. If a train approaches while the curtain is down, it throws a switch that causes the curtain to rise.

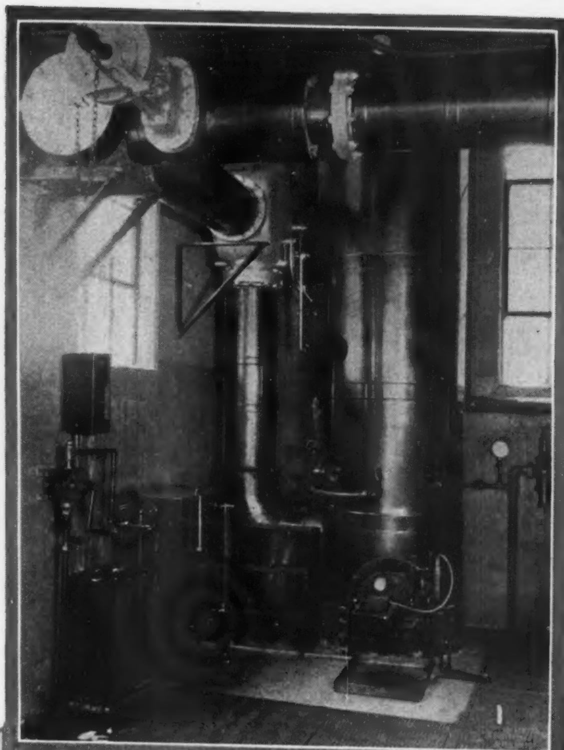
To gain an idea of the ventilating system and how it works, visualize a concrete building flanking the tunnel line at its eastern end. At either end of the building a square tower rises to a height of some 50 feet above the ground. On three sides and in the upper part of each tower are sheet-iron windows. These are the louver gates that help to guide the air flow, as desired. The lower portions of both towers open into one side of the tunnel. Each of these openings is fitted with a large iron damper that can be either swung against the opening to form a door or raised in a horizontal position so as to form a temporary ceiling in the tower room, closing off the lower from the upper part of the structure. Now picture a circular fan, 9 feet in diameter, on the ground floor of the tower nearest the tunnel portal—the fan facing the opening leading from this tower into the tunnel. This fan, with blades like an old-fashioned water wheel, takes air in at the front and discharges it at one side through a concrete duct into the lower part of the second tower.

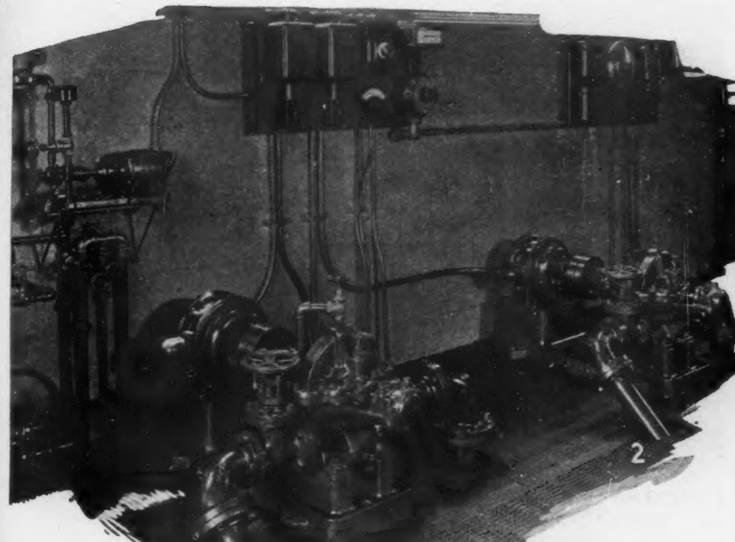
Remembering that this equipment is at the eastern tunnel portal, let us assume that a train is about to come through the bore from west to east. We want to blow fresh air against it. We lower the damper over the opening from the tunnel into the fan room, and open the louver gates in the tower above the fan. Then we close the louver gates in the adjacent tower, and lift the iron damper away from the opening which connects the lower part of this second tower with the tunnel—the damper temporarily serving as a ceiling for this room. Then we lower the cur-

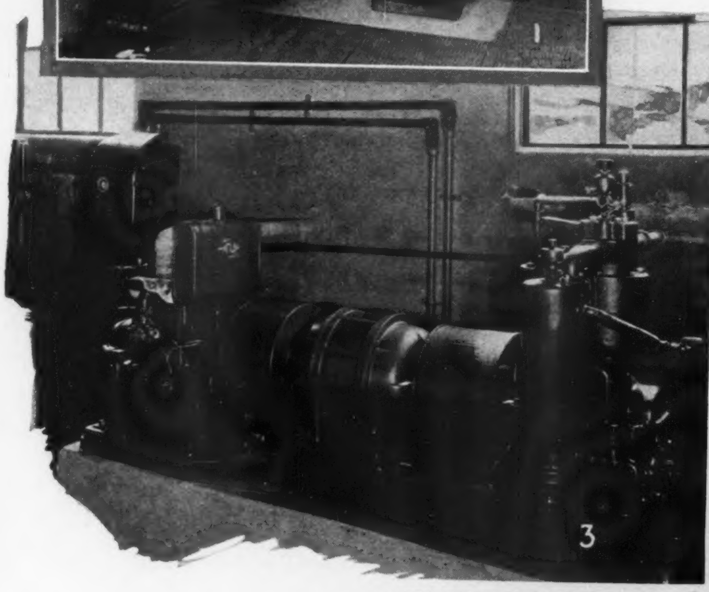


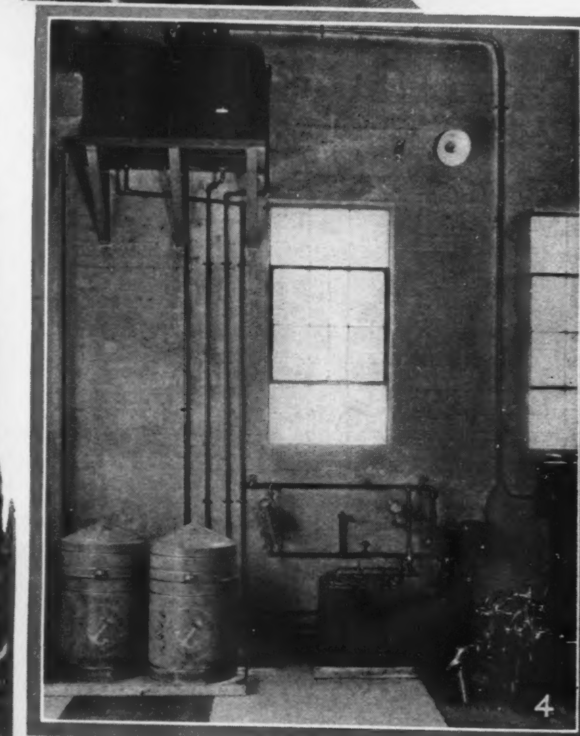


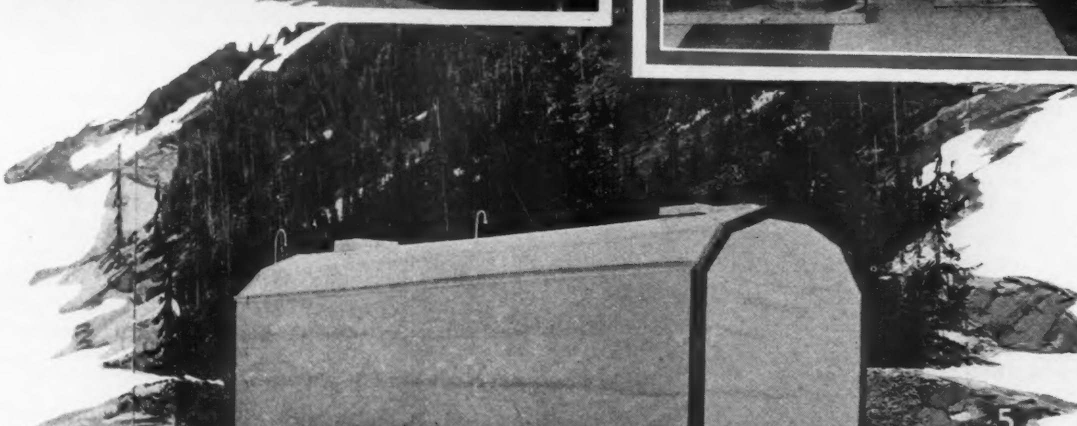
Left—The 500-hp. motor that drives one of the ventilating fans by means of the shaft extending through the wall at the left into the separate fan room. Right—Air intake for the oil engine and exhaust piping at the right.



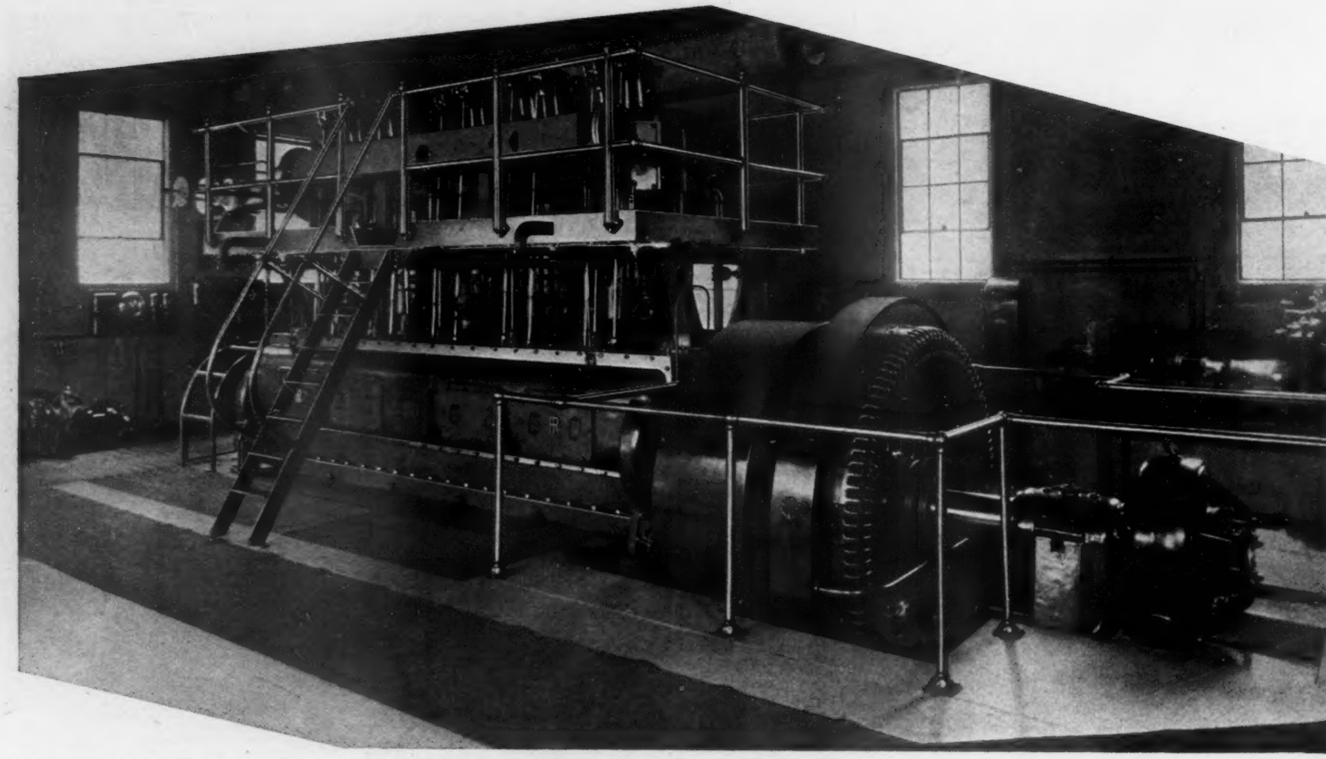








1—The heating boiler that is fired by either the engine exhaust or an oil burner. 2—Cameron Type NFV pumps that supply cooling water to the engine. 3—Type 20, two-stage compressor which provides starting air for the oil engine. 4—Fuel-oil supply tanks with pump and piping system. 5—Structure housing fuel-oil storage tank, which is insulated for protection against the cold.



The 5-cylinder, Type PR oil engine, direct connected to a 400-kw. generator and its exciter. This unit furnishes the power to operate the motor-driven ventilating equipment.

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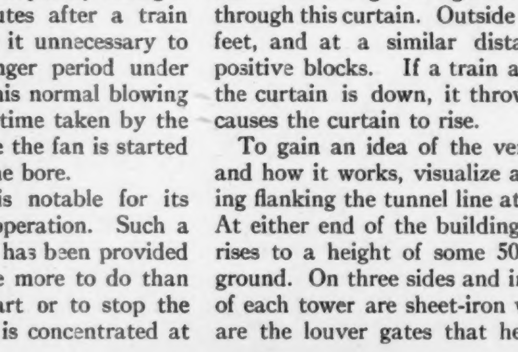

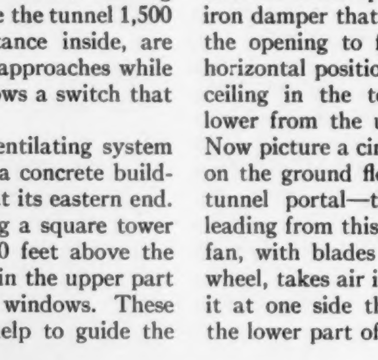

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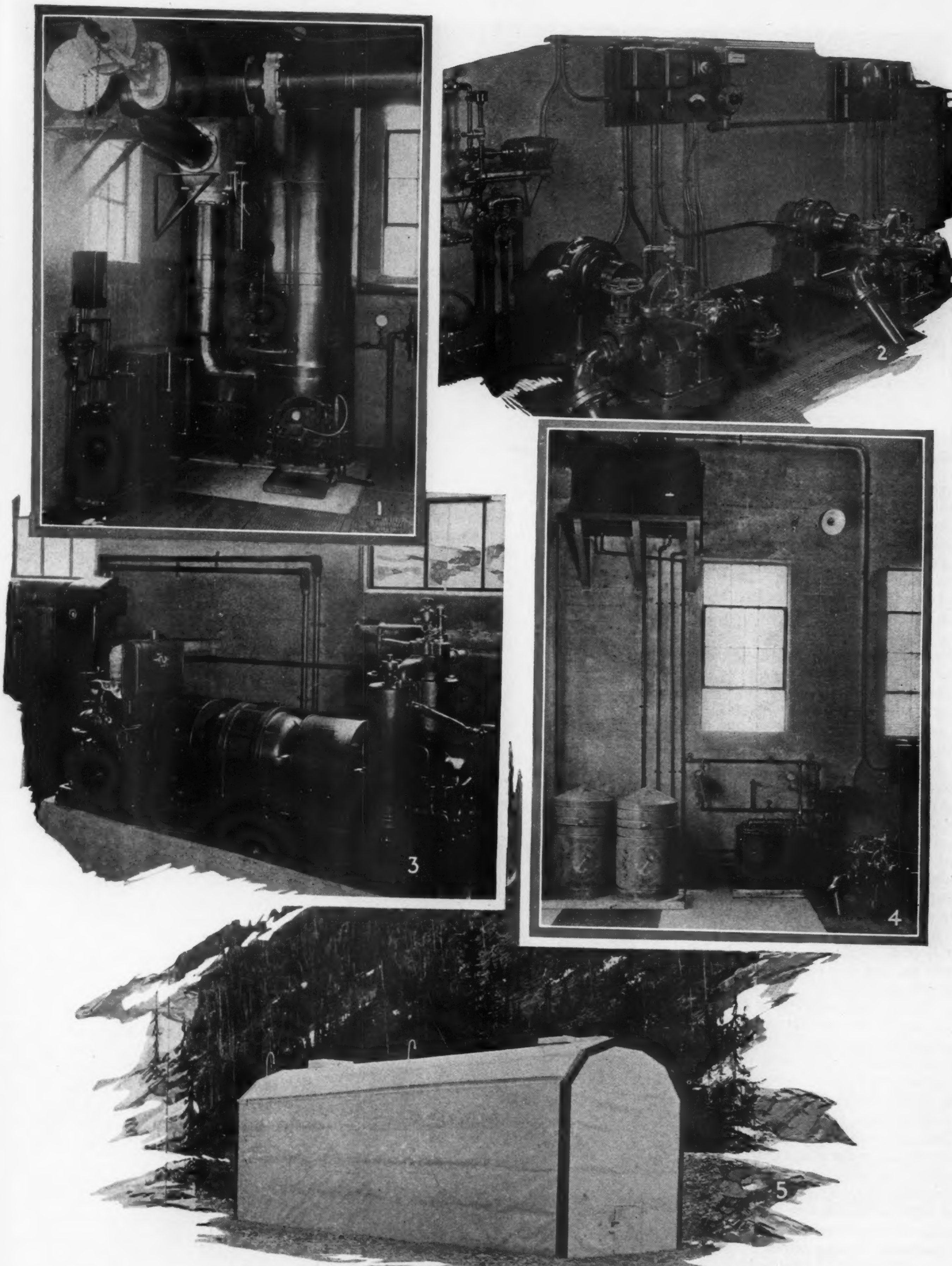

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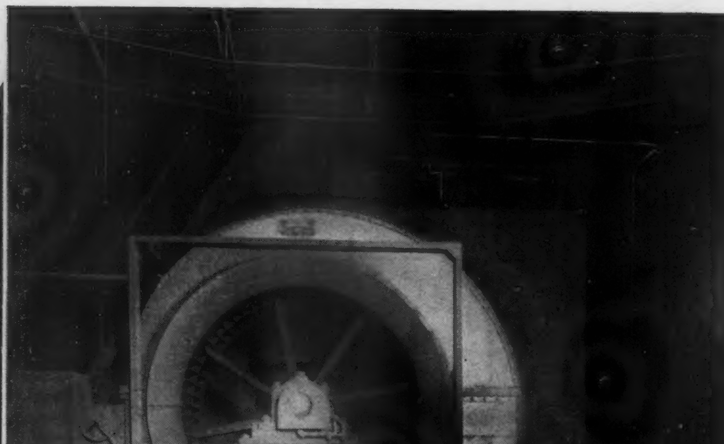


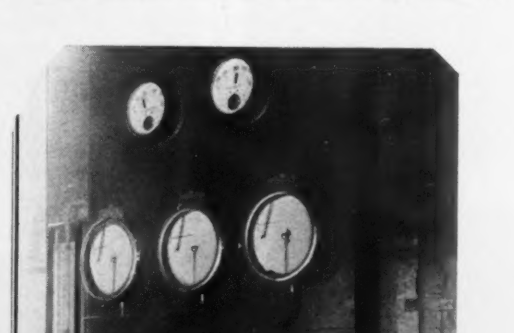
Left—Front view of one of the fans. Part of the raised damper may be seen overhead. Right—Same opening as at the left but with the damper closed.

tain over the tunnel mouth, thereby starting the fan. Air from the outside comes through the gates in the fan-room tower and is blown by the fan through the duct into the adjoining room and thence into and through the tunnel.

If the train is running from east to west, we want to induce a draft against its movement by drawing fresh air through the tunnel from the west end. To do this, we raise the damper blocking the opening from the tunnel into the fan room; close the louver gates overhead; lower the damper in the adjoining room over the opening through which air was previously blown into the tunnel; and open the louver gates in the associate tower. We are then ready to lower the curtain at the tunnel portal and to start blowing. Tunnel air, including the smoke and gases from the train, is now drawn into the fan; discharged, as before, into the adjoining room; but exhausted to the outside through the louver gates above. In actual practice, all this adjustment of dampers and gates is done very quickly and easily. The operator merely throws a switch on his control board to "West Bound" or "East Bound," as the case may be, and the proper movements are made by motors.

Atmospheric conditions have considerable bearing on the time required to blow the tunnel free of smoke. The western end is 113 feet lower than the eastern end. The resulting difference in barometric pressure is sufficient to cause a slight natural draft from west to east. Moreover, the prevailing winds are from west to east. At times, in winter, these natural agencies combine to create a flow of air through the tunnel that registers 1¼ inches of water pressure. The strength of this current can be judged by the fact that 6 inches of water pressure is the maximum blowing pressure used and that 2 inches suffices under normal conditions. The pressure is naturally greater while a train is passing through, due to the resistance thus offered, and the power required to operate the fan increases accordingly.

In keeping with the general over-all efficiency of the installation is the equipment that provides the necessary electrical energy to operate the fan. During the first nine months that the tunnel was open, purchased power was brought in over the transmission lines used during the driving of the bore. Since December, 1928, power for the fan motor has come from an oil-engine-generator unit, and material savings have resulted. This has entailed no additional personnel—the same force of three men for 24 hours continues to operate the plant as before. The several small auxiliary motors and the lights still draw on outside power, as their maximum demand does not exceed 10 hp. and it is impractical to operate the generator to supply their needs. The generator delivers power to the switchboard through 2-way switches, which arrangement makes it possible to put the entire connected load on either the generator or the outside service lines. Thus each system constitutes a reserve for the other in case of emergency. Thus far, the oil engine has never been out of service.



Electrical control board from which the tunnel ventilating system is operated.

The generating equipment consists of an Ingersoll-Rand vertical, 5-cylinder, 4-cycle, solid-fuel-injection oil engine of the Diesel type, direct connected to a General Electric 400-kw., alternating-current generator with direct-connected exciter. Power is generated at 2,300 volts.

The oil engine has an altitude rating of 585 b.hp. at 257 revolutions per minute. To off et the loss of power at this altitude of 9,200 feet, the engine was equipped by the manufacturer with a supercharger which delivers air under a pressure held between 4.6 and 4.9 pounds directly into the engine intake, thereby building up the engine intake pressure to about that at sea level. The supercharger is a Connersville blower, driven from the engine shaft by Texropes at twice the engine speed. Air is taken from the outside; but provision has been made for inside intake should extreme cold necessitate the change. Thus far the engine has never failed to start promptly on atmospheric air, which is warmed about 80° F. in passing through the blower. The power consumption of the blower is about 50 hp., but it increases the engine's output by approximately 165 hp., a net gain of 115 hp.

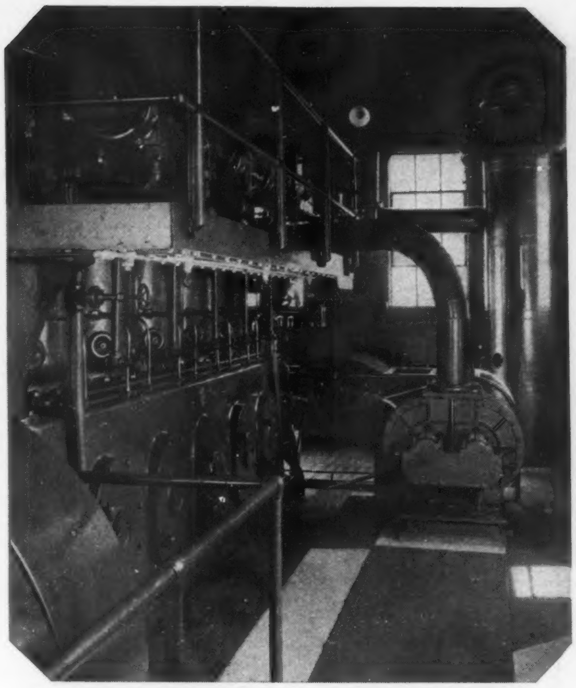
To insure engine cooling water of the proper temperature, a 1,500-gallon tank is provided in a pit beneath the floor for the mixing of hot water from the engine discharge with cold water entering through a gravity line from the outside. When the tank temperature reaches 90° F., a thermostatically controlled valve admits outside water, which is auto-

matically shut off when the tank temperature drops to 80°. This cooling water is fed to the engine by a Cameron Type NFV centrifugal pump, rated at 115 gallons per minute against a 50-foot head. A duplicate standby pump also is installed. By means of a valve adjustment, cooling water is supplied the engine directly from the outside gravity line in case of pump failure.

Fuel oil is stored in a 30,000-gallon tank a short distance from the engine room. As a protection against the extreme cold that sometimes prevails there, this tank is insulated with 18 inches of sawdust, and steam coils are ready for use if required. The oil delivery line into the engine room is encased in insulated tile pipe. Oil from the storage tank first enters a 50-gallon tank placed beneath the floor adjacent to the cooling-water mixing reservoir. It is then pumped into overhead day tanks, from which it flows to the engine by gravity. A "Pressuretrol" system is installed that rings an alarm if either the water or the oil pressure to the engine should fall to a certain point.

The engine exhaust is utilized in winter for heating the building by directing it into a Davis Paracoil boiler. Steam has been raised by this means in 20 minutes; and it has been found that a total of four to five hours of intermittent operation of the engine in 24 hours will keep the rooms comfortable on the coldest day. A Ray automatic oil heater is used under the boiler when the engine is operated infrequently during extreme cold spells. During warm weather the engine exhaust is directed outside, through a muffler.

In starting the engine, compression relief cocks are opened on all five cylinders at one operation by means of an interconnected system. Starting air is provided by an Ingersoll-Rand Type 20 two-stage compressor. It is normally driven by a motor, but an expanding coupling permits its operation by a gasoline motor in case of failure of outside power. Four air receivers are provided for storage of the starting air.



The oil engine and, at the right, the positive-pressure blower that serves as a supercharger.

When a train is approaching the tunnel, the dispatcher notifies the operator of the ventilating plant by telephone so that he may start the engine and prepare the equipment for blowing air in the desired direction. By actual timing, it requires only three minutes to do this, after which the operator informs the dispatcher that he is ready for the train.

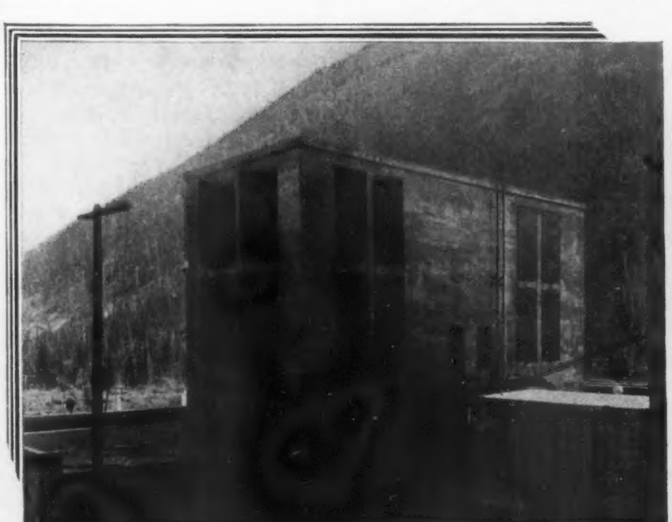
This ease and dependability of starting, which is one of the outstanding features of this type of engine, results from the simple and reliable system of fuel injection employed. Fuel oil is delivered to an injection pump and then discharged through a distributor to the engine cylinders, each of which receives an equal charge. Through the action of the governor on the distributor, the fuel charge to the cylinders is altered by the slightest change in the speed of the engine, thus insuring a quick pick-up of the load in addition to easy starting.

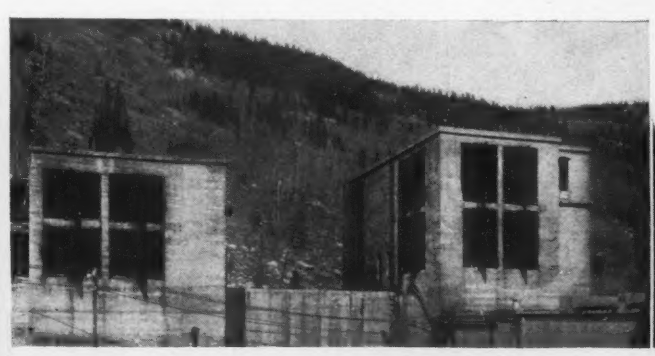
The effective action of the governor is well shown in this installation. Despite the frequent starts and stops, wherein full load goes on at once or the load drops abruptly from full load to no load, the governor functions perfectly; and there is no discoloration of the engine exhaust by smoke except during the brief interval of transition from full load to no load.

The fuel economies of the engine are very satisfactory, the oi consumption being closely in line with that for sea-level operation of similar units. It is difficult to estimate the average operating time per day, as the number of trains varies greatly from season to season. A check of the records for one week, selected at random, showed an average daily operating period of 6.47 hours. The period of time over which each blowing extends likewise varies widely. A passenger train runs through the tunnel in from 9 to 11 minutes, and makes but little smoke to be cleared out, while a freight train may take as long as 25 minutes to go through and create a dense smoke. When work trains are moving within the tunnel, the plant is sometimes operated continuously for several hours.

A few figures, comparing the former with the present train schedules, will suffice to indicate how the tunnel has shortened the run from one side of the divide to the other. Between Tolland, two miles east of the tunnel, and Vasquez, just west of the bore, freight trains now have a running time of 40 minutes in either direction. When the line ran over the pass it took four hours to cross westward and 4 hours and 50 minutes to make the eastward run. In winter, storms often blocked all traffic between these points for days at a time. The present length of that segment of the line is 11.48 miles, as compared to 33.95 miles before the tunnel was driven.

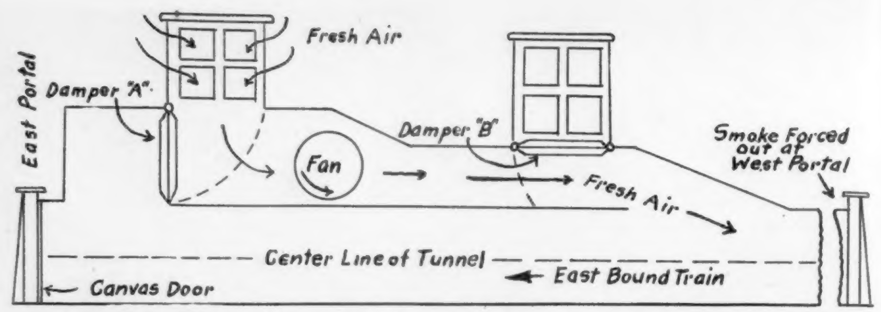
In designing the ventilating plant, the engineers used as the permissible carbon-monoxide content in the tunnel air the figure of .04 per cent previously arrived at by investigations





Left—Smoke being exhausted from one set of louver gates. Right—General view of the ventilating-plant towers showing some gates open and some closed.

preliminary to the construction of the Hudson vehicular tunnels between New York and New Jersey. It was computed how much air would be required to dilute to this percentage the carbon monoxide contained in the smoke from an engine of the largest type used on the road when burning the maximum amount of coal. The plant was then designed to force such a volume of air through the tunnel. The results have been fully up to expectations, and two years of operation have shown that the plant could satisfactorily ventilate the tunnel if traffic were increased to several times its present proportions.



Diagrammatic sketch showing how the ventilating system works when air is being blown from east to west. For blowing from west to east, Damper "A" is closed and Damper "B" is opened. The smoke-laden air is then drawn into the fan from the tunnel and exhausted to the atmosphere through the tower above Damper "B". In both cases, the canvas door is lowered at the east portal during blowing.

WELL-ORGANIZED SHIFTS DO GOOD WORK ON HOOPER TUNNEL

WORK on the Hooper Tunnel, which is being driven for the Bunker Hill & Sullivan Mining & Concentrating Company at Kellogg, Idaho, is advancing rapidly—in fact, reports have it that record work is being done by the crews on the job thanks to good organization and to a fine spirit of coöperation on the part of all concerned. The company in question is supplying all the equipment that is being used, while the contractor, J. Fred Johnson, is furnishing only the men and the explosives. The workers are being paid a bonus for any footage drilled over and above that required of them, a stimulus to further effort.

But before we tell how the contractor is accomplishing the results he is, it should be said that the Hooper Tunnel, which will connect the Crescent Mine with the Company's mill, was planned to facilitate the transportation of ore from the mine to the mill, which is so situated in relation to the portal of the tunnel that the ore will flow thence by gravity to the various machines in the mill. This will do away with the gravity train that now handles the ore between those two points. The tunnel has a cross section of 8x8 feet, and will be about 5,000 feet long. It is being driven through Wallace quartzite and, so far, except for the first 100 feet, has required no timbering.

Before the present highly satisfactory cycle of operations—which will be described presently—was put into effect, the contractor first employed two drill shifts per day, the mucking gang coming in between. This schedule was changed because the muckers could not finish their work in the time allotted them. Then three shifts of drill runners and helpers were tried, the helpers also serving in the capacity of muckers. Blasting was done whenever the men were ready, no definite time limit being set for any of the operations involved. This gave way to a third working cycle, which has resulted not only in lower costs but also in increased footage.

Tunneling, as now practiced, is being done by two shifts, each of which drills, blasts, and mucks a round. In each shift there are two groups of machine men, and each drill is set up independently at the heading. Ingersoll-Rand S-70 drills, with 1¼-inch, round, hollow steels are utilized. Anywhere from 26 to 30 holes are drilled to a round; and a 7-hole cut is required. The cut holes are blasted simultaneously with twelve sticks of 60 per cent gelatine to the hole. Both instantaneous and delay electric detonators are employed to fire the round. The use of long-carriage drills in this case is an advantage because fewer changes of steels are needed and the time thus saved can be spent in drilling. This means of course that the steels should be well sharpened, so that they will be able to drill the footage expected of them. The sharpening, as well as all other kindred outside work, is being done by the contractor.

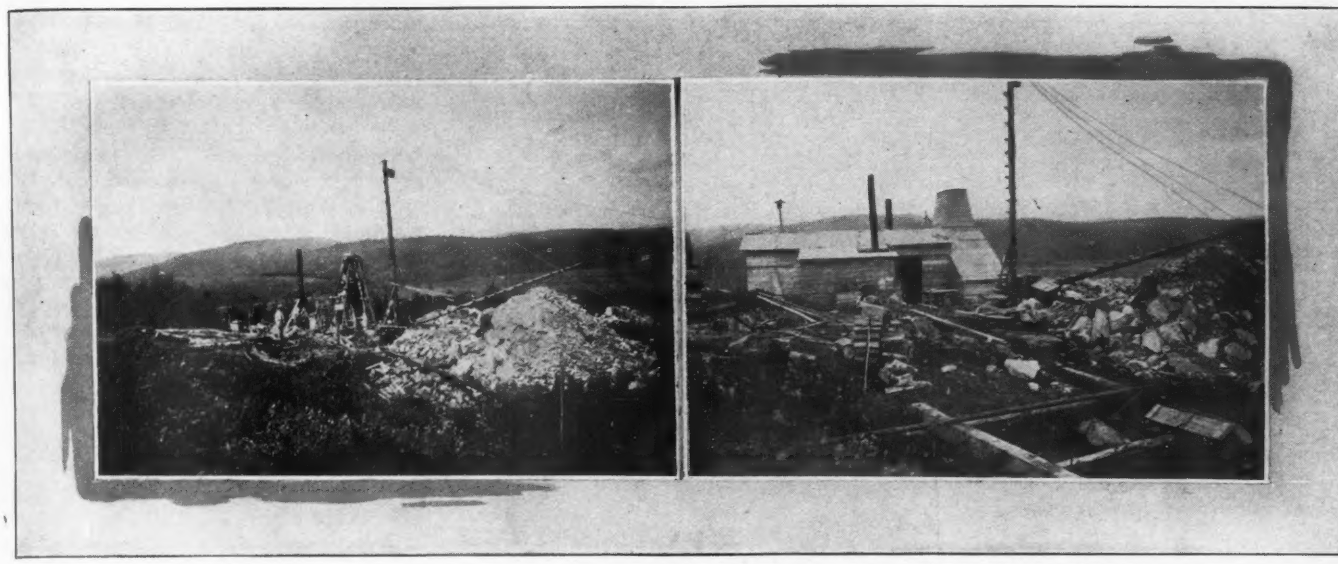
The hours each shift is on the job are divided about equally between drilling and mucking. The latter is done by a Nordberg-Butler shovel which is being run by one of the drill men. It has proved far more satisfactory for the purpose than hand shoveling, especially in cleaning up. The shovel is a Model 110, and is operated with compressed air, consuming about 240 cubic feet per minute at 90 pounds pressure. The excavated material is carried away to the dump in 40-cubic-foot cars, which are hauled by a storage-battery locomotive; and about 30 cars are loaded to a round. In this way, the men have been able to advance the tunnel 223 feet during 29 shifts, or an average of 7.69 feet per shift. The best record reported up to this writing was for three consecutive working days when something more than 47 feet were driven.

Keystone View Company, Inc.

This metal-spraying equipment, based upon apparatus originally conceived by an ingenious Swiss, can be used for coating the surfaces of all sorts of materials. Here a pair of slippers, manifestly not Cinderella's, are being made like new with a fresh film of gilt. The melted metal is atomized and deposited by a jet of compressed air.

RESTORATION OF ST. PAUL'S NEARING COMPLETION

THE doors of St. Paul's Cathedral, it is reported from London, will again be thrown open to the public for inspection and worship sometime during June, when the work of restoration will have been completed. The grouting of the piers that carry the great dome has been finished, and one of the heavy stainless steel chains used to bind the dome is in position. This chain is composed of links 15 feet long and 2 feet high; has a total length of 450 feet; and weighs 30 tons. The second chain, which remains to be put in place, is of double that weight. The entire undertaking has involved an expenditure of more than $2,000,000, and insures the integrity of this imposing edifice for generations to come.



Left—Surface activities on the property of the Montauban Metal Corporation. Right—Blacksmith shop and compressor house erected at a later date.

Portable Compressor Proves Its Value In Prospecting Work

By J. N. HERRING*

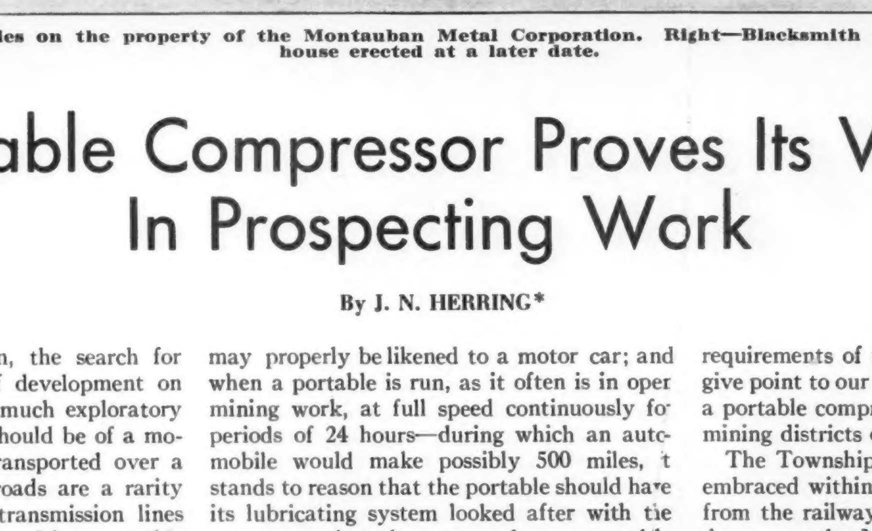
AS a general proposition, the search for ore deposits capable of development on a commercial scale entails much exploratory work; and the plant used should be of a mobile nature that can be transported over a rough region where good roads are a rarity and railroads and power transmission lines have not penetrated. Gasoline-driven portable air compressors have proved especially suitable for developmental operations under the conditions just mentioned.

In most cases where a payable ore body is uncovered by preliminary development, the next step is to equip the property for regular production. When production reaches a fairly large tonnage, and a permanent power plant of suitable size is provided, then the portable-compressor outfit can be profitably disposed of or even moved to advantage to another field of service. In short, the portable compressor is flexible and mobile, and readily adaptable to the varying circumstances that mark the initial or exploratory stages of mining ventures in out-of-the-way sections of any country.

Within certain limits, a portable compressor may properly be likened to a motor car; and when a portable is run, as it often is in open mining work, at full speed continuously for periods of 24 hours—during which an automobile would make possibly 500 miles, it stands to reason that the portable should have its lubricating system looked after with the same care that the owner of an automobile would give to his car. And because of this kinship of the gasoline portable compressor with the motor vehicle, it is not difficult to interest men in caring for such a compressed-air plant—familiarity with the needs of a car making it easy for them to understand the requirements of the compressor. Now let us give point to our preamble by citing just what a portable compressor has done in one of the mining districts of Canada.

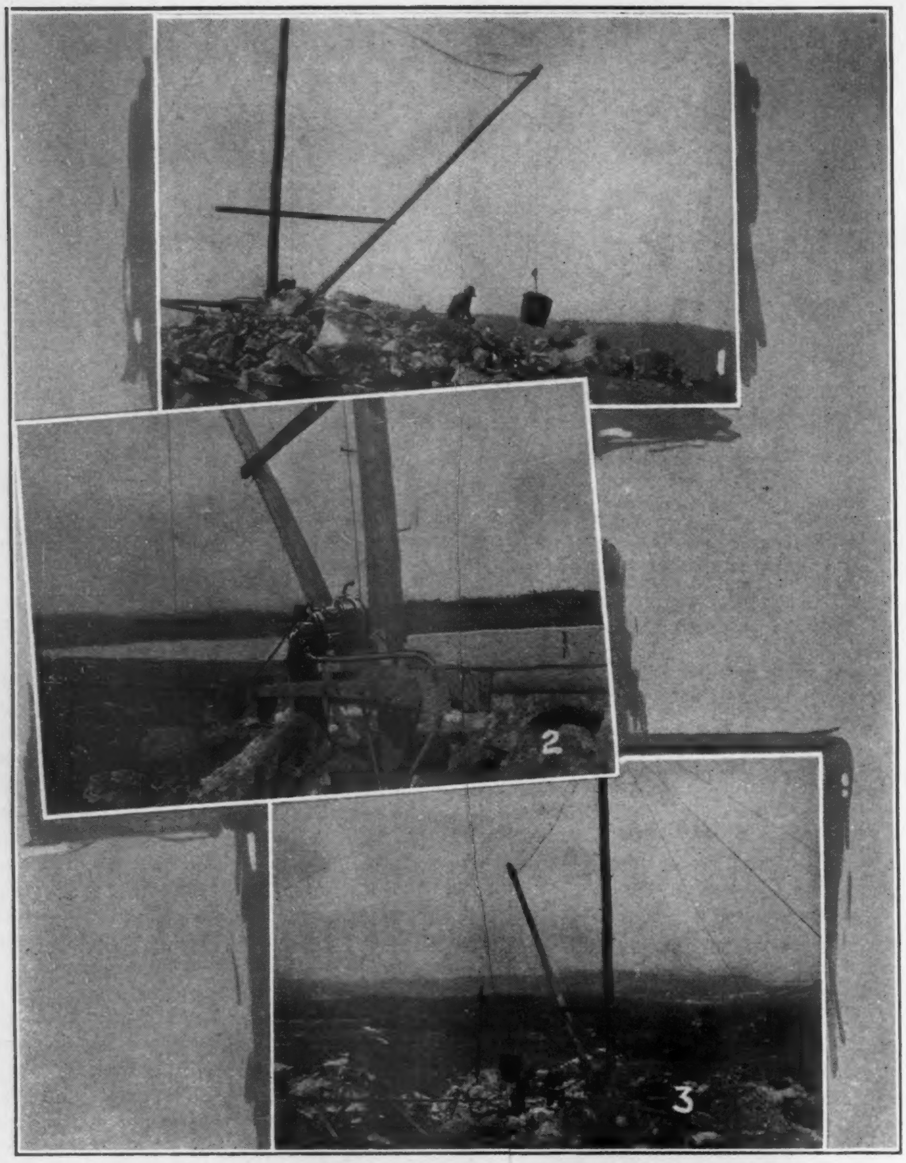
The Township of Montauban is a district embraced within a radius of about five miles from the railway station of Notre Dame des Anges, on the Montreal-Lake St. John Line of the Canadian National Railway. In this district are scattered surface indications of zincblende and lead sulphide; and these outcroppings have led to considerable prospecting activity. The Tetreault Mine is the most conspicuous of the developed properties, and has been worked at various times during the last decade and a half—latterly with notable monetary returns. The metallic deposits are limestone replacement bodies.

The property undergoing investigation by the Montauban Metal Corporation consists of a limestone outcrop that has been uncovered for a total length of about 1,000 feet; and a preliminary part of the work has called for a deep open cut along this outcrop. The equipment chosen for the purpose was a 10x8-inch, Type 20, portable compressor on skids, an oil furnace,



Left—Bottom of the shaft. Right—An N-70 Ingersoll-Rand drifter at work on the property of the Montauban Metal Corporation.

*Montauban Metal Corporation, Ltd.



1—Derrick equipped with an air-operated "Utility" hoist. 2—Close-up of the "Utility" hoist mounted on the derrick. 3—Hoisting muck from the first 50 feet of shaft sunk near the derrick.

a drill sharpener, a "Utility" hoist, and two "Jackhamers"—the portable furnishing compressed air for all the other equipment enumerated.

In order to save time in setting up the equipment, work was commenced before its arrival on a building ample enough to house the compressor and the other machinery. In fact, the structure was started when the order for the outfit was placed, and this happened to be at a season of the year when the site was covered with several feet of snow and the temperature was around zero. A 2-hp. portable gas engine, already on the property and used for pumping, was belted to a home-made 8-inch circular saw bench. A few thousand feet of 1-inch plank and 4x2-inch scantling were quickly cut up into 4-foot lengths—using a sliding template on the saw table to insure uniformity. In the same way, 8-foot lengths of 4x2-inch stuff were cut up. These were knocked up into 8x4-foot panels. Each of these panels had only to be bolted to its fellow to provide a building that could be dismantled just as quickly as it was erected and be as portable as the machine it was intended to house. The shed was made 24 feet by 16 feet, but was later enlarged by the addition of more panels in order to afford room for the drill-steel sharpener. All machinery was landed at the nearest railroad station on March 9, 1928, and hauled to the property on skids over snow for a distance of about three miles. The last mile included a rise of 400 feet, and eight horses did the pulling. Five days later the whole outfit was ready to begin work, and but four men were required to do the installing.

Being indoors, it was necessary to provide an air intake for the compressor and an outside exhaust for the engine. These were made out of old 3-inch boiler tubing, with the ends welded to suitable flanges cut out of ½-inch plate. The sheet-steel top and sides of the housing were removed from the portable to insure cooler running. A 40-gallon wooden barrel was used to fill the circulating system with water by gravity. This would be desirable anywhere under conditions that are such as to require the radiator to be emptied nightly. A gasoline storage tank was set up at a safe distance outside and piped so as to feed fuel to the compressor by gravity. A half barrel, filled with sand, was placed alongside the machine for service in case of fire.

After the open cut had been excavated to a suitable point, shaft-sinking was started in that trench; and after the shaft had been sunk about 50 feet it was considered safe to move the portable compressor to the shaft collar. To do this, a substantial bracket was bolted to the compressor frame; and to this bracket a "Utility" hoist was secured. Next, a track was laid, upon which sections of 4-inch pipe were placed to serve as rollers; and over these the compressor was pulled into position—a distance of more than 300 feet—by the hoist which used air furnished by the compressor. The same hoist also did duty at the derrick shown in some of our illustrations. Shifting the compressor from the building to its new position took only two days, and rough ground had to be traversed in making the change.

At the start of shaft-sinking, light "Jackhamers" were employed, but shortly afterwards an N-70 sinker was substituted, and the work went forward more rapidly. A light Cameron boiler-feed pump, that could be easily shifted by one man, was used during sinking to take care of incoming water that seeped into the shaft at the rate of about 100 gallons an hour. At a depth of 100 feet, a 2-cylinder, air-driven friction hoist took over the task of hoisting in the shaft. This machine handled a bucket having a capacity around 600 pounds. The bucket was fashioned of an old steel oil drum and was arranged to run on wood skids made of 4x2-inch scantling bolted together to make 4x4-inch material. Each section was 10 feet in length, and pegged to the foot wall at each joint with a drift pin driven into a pop hole. The joints were secured with steel plates suitably bolted. The bottom 30 feet of the run was hoisted out of danger before each blast.

The compressor was called upon at certain stages of the work to operate, intermittently, the drill sharpener, the oil furnace, the pump, and the hoist. Taking at random a period of a month, during which the plant ran 24 hours daily, or a total of 554 hours—with stops only to change oil on alternate days, the following gasoline and oil consumption was recorded:

	Gallons (*Imperial*)	
Gasoline at 22½cts. a gal.	1,129	$254.03
Oil at $1.02 a gal.	34	34.68
		$288.71

Drilling and mucking were carried on continuously by three shifts working eight hours each. Apart from stops to change oil—a matter of five minutes each, the only other interruption was due to a broken fan belt. A gasoline gage, a sketch of which is shown, was provided before the plant was put in service; and the information given by it as to the condition of the machine amply justified the small amount of work involved in

making it. The daily logging of the gasoline consumption has served to indicate any falling off in operating efficiency. The whole secret of economical consumption of fuel and quiet and cool running of the machine lies in the condition of the valves of the motor. Night-and-day running is a severe test of the valves of an internal-combustion engine. To keep up compression, and thus insure maximum power output, the tappet clearances must be looked after and, if necessary, adjusted weekly. As a regular routine, the head should be removed and the valves ground in monthly. A neglected valve in the engine soon leads to missing, to stalling, to heating, to falling off in power, and to irregular running and crankcase dilution. A set of feelers for testing the tappet clearances of the valves is indispensable. Another essential tool is a revolution counter. We have found the Veeder counter admirably suited to this service because it is fitted with a clutch and is easy to use.

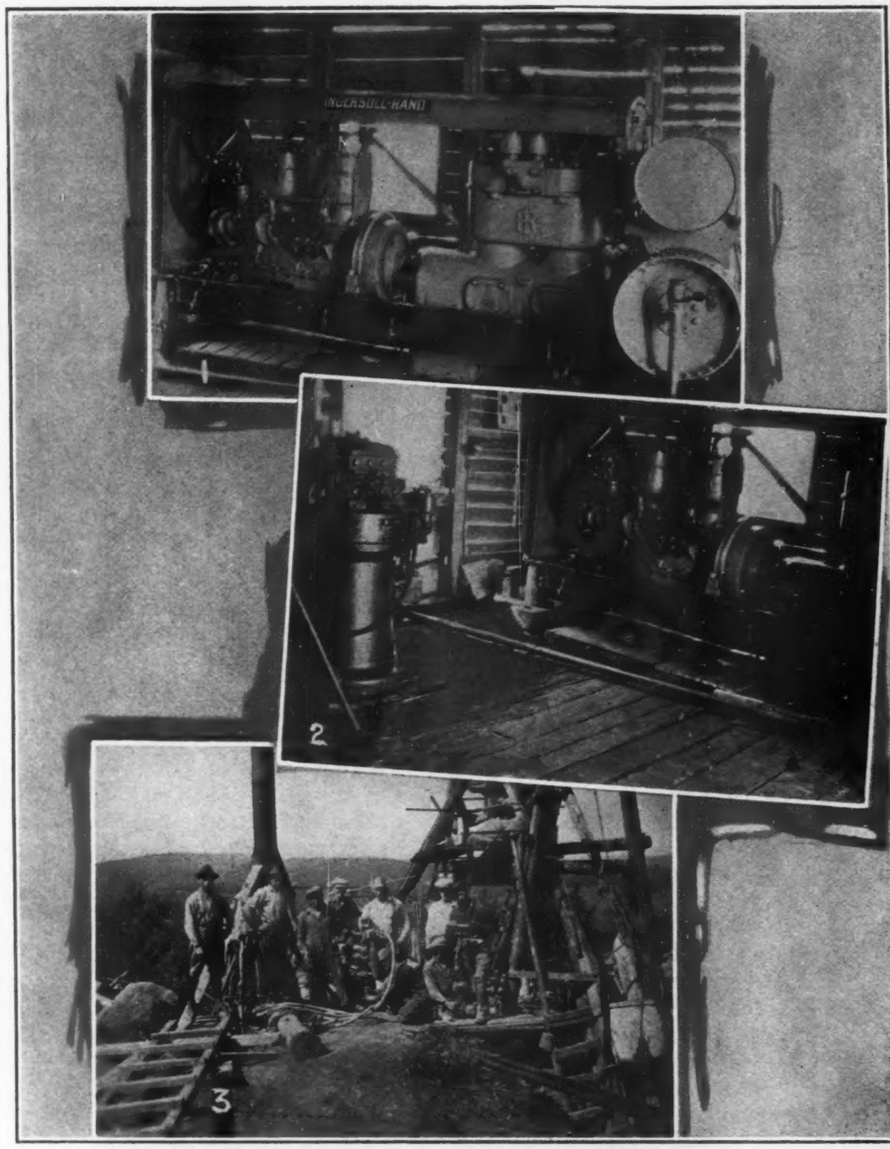
Idling at too high a speed, much in excess of 600 revolutions per minute, leads to high gas consumption and heating. The maximum running speed of the gasoline engine on the 10x8-inch compressor is set by the makers at 1,080 revolutions per minute. It has never been found needful in practice to approach this speed in handling the load previously mentioned. The following speeds were registered when the machine was adjusted to take care of the loads given without cutting out:

With drifter only..............	770 r.p.m.
With drifter, oil furnace, and sharpener..................	845 r.p.m.

These figures include line and leakage losses in 300 feet of piping. At no time has it been found necessary to exceed 900 revolutions per minute.

The infrequent and short loads imposed by the hoist and the pumps have been allowed to pull down the receiver pressure, with no inconvenience, rather than to attempt to meet them by a high number of revolutions all the time. Generally speaking, it has been found better to run under speed than at high speed with continual cutting out. It is interesting to note that the replacement of the makers' 2-inch connection from the receiver with 3-inch piping down the shaft and 1-inch air hose on the machine led to a good deal of drill breakage. The pressure at which the machine cuts out was lowered 10 pounds, and then the breakage ceased. With a machine of the capacity of the 10x8-inch compressor it is expensive to overcome friction losses in small-diameter pipe lines of great length—such as are necessary in a mine—by excessive pressure at the receiver, as is commonly done. With lines of ample size, a pressure of 80 pounds at the receiver is sufficient. This indirectly represents another source of gasoline economy.

A second-hand boiler of 15 hp. was installed at the shaft head and arranged so as to function as an air receiver or a water reservoir. With or without pressure on the water, it supplied the drifter. When serving as a reservoir, it was fed with water from the pump in the shaft. In the wintertime, the same boiler was fired



1—The 10x8-inch portable compressor that supplies air on the property in Montauban. 2—At left is the No. 34 Ingersoll-Rand sharpener used to condition all drill steels. 3—Headframe, with temporary hoist, at scene of operations.

and made to furnish steam for hoisting at night and also for heating when the temperature was around zero. Obviously, given two working faces, the small boiler—supplementing the portable—doubled the mining capacity of the plant by making it possible to carry on drilling and mucking simultaneously day and night.

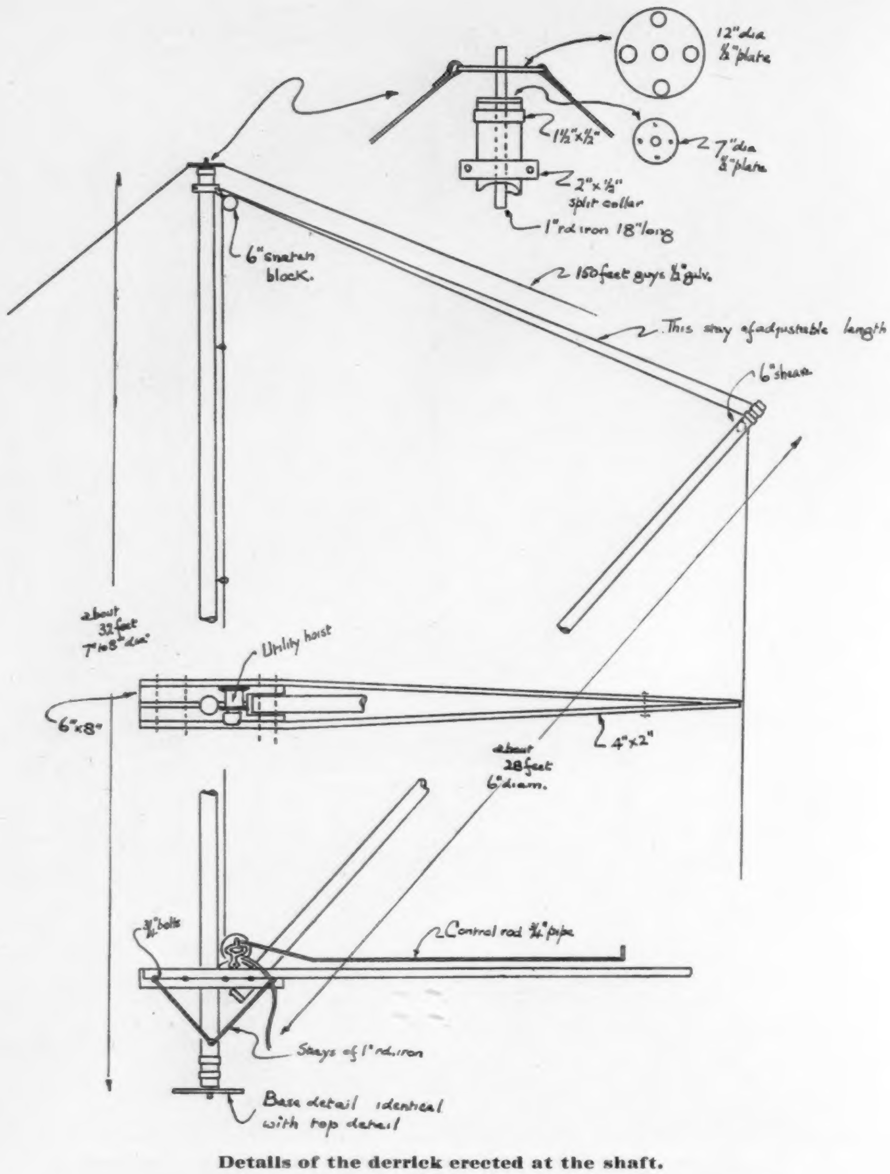
The following data having to do with this method of operating may prove of interest to others engaged in similar work under kindred conditions: Eight men are on the job. Of these, one driller, one helper, one hoistman, and one blacksmith are employed during the day, while one foreman, one hoistman, and two muckers are on duty at night. These men are on contract, and are paid on a footage basis. The hoistman also keeps the boiler going and dumps the mine car.

During a period of 58 working days 118 feet of 9x7-foot shaft was sunk and a 7x5-foot drift advanced 119 feet. Included in the 58 days is the time lost at the portal and that lost in well hitching for and in installing a platform at a point 15 feet above the bottom of the shaft, that is, above the sump.

In that time the compressor ran 665 hours and consumed 1,512 gallons of gasoline at a cost of $340.20. This includes all the gasoline as invoiced and delivered, less stock on hand, as well as that used in the oil furnace—for that purpose diluting it with old oil from the compressor. Illumination is furnished by five Coleman gasoline lamps. The engine, the pumps, and the drills used 79 gallons of oil worth $80.58.

The sharpener on the premises was called upon to recondition 2,898 drill steels, doing the work in 193 hours at an expenditure of $34.43 for 313 gallons of fuel oil.

Shaft-sinking and drifting involved the drilling of 896 holes, representing an aggregate footage of 4,947; and 12 tons of coal were burned in hoisting the 987 tons of rock excavated. The spares needed included two fan belts for the compressor, $7.80, and one anvil block and four pawl springs, costing $6.90 and $0.48 respectively, for the drifter-



Details of the derrick erected at the shaft.

sinker. No other parts were required nor purchased. The compressor was operated for about an hour every night for blowing the gases out and away from the working face.

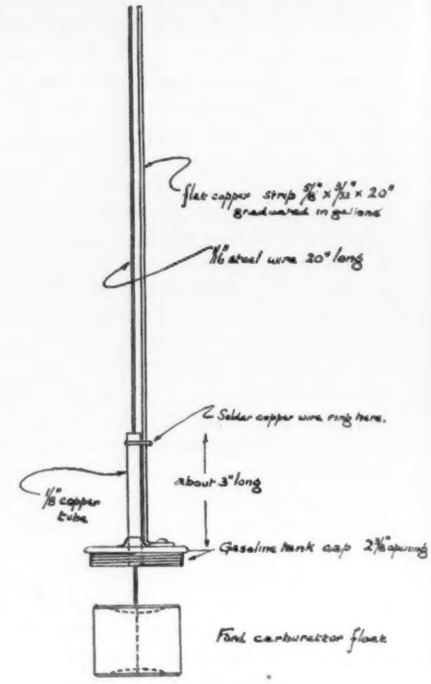
At the time of writing, the amount of underground work done totaled 700 feet of sinking, drifting, and crosscutting. A careful examination of the invoices covering the entire 10-month period shows that the compressor was run at an expenditure, exclusive of gas and oil, of $41.72.

To maintain a portable compressor in first-class shape it is essential that the following spare equipment be available: Compressor inlet valve, complete; compressor outlet valve, complete; 2 motor valves; 4 spark plugs; 4 porcelains for the spark plugs; set of feelers; revolution counter; tin of valve grinding paste; and a valve refacer. The spare valves mentioned are not required so much for breakdown use as they are to keep the plant going when it is necessary to clean those in service—a spare being slipped in the machine for the one that needs cleaning and grinding, which can then be done at leisure.

PETER F. BRENDLINGER

IT IS with deep regret that we announce the death on December 16, and just as he was rounding out his eightieth year, of Peter F. Brendlinger, father of W. B. Brendlinger, manager of the Philadelphia office of the Ingersoll-Rand Company. Mr. Brendlinger was a retired construction engineer and especially well known in railway circles because of his long identification with the Pennsylvania Railroad.

For years he was Chief of its Schuylkill Valley Division, and, among other important projects, built for that road the section between Reading and Pottsville and the Point Bridge at Pittsburgh. Severing his relations with the Pennsylvania, he associated himself with Brown, Howard & Company, of New York; and, in the capacity of engineer, played an important part in the construction of the aqueduct of the Catskill Water Supply System of Greater New York. Later, while in business for himself, he again did much work for the Pennsylvania Railroad, including



Gasoline gage.

the driving of the new tunnel through the Allegheny Mountains at Gallitzin, Penn., and the widening of the old one.

COBWEBS FOR SURVEYORS

DID you know that the cross hairs in the surveyor's transit are spun by spiders? The Physical Testing Laboratory of the Topographical Survey of Canada bears out this fact and tells us that many yards of this delicate filament are required annually for these instruments. That department obtains its annual supply in the early autumn, when an instrument maker visits the Dominion's greenhouses at the Central Experimental Farm and returns to the laboratory with perhaps six spiders of medium size and of a mottled gray color.

Each spider is made to run about on a wooden stick until its web has adhered to it. Then the stick is gently tapped to dislodge the spider, which industrially spins away during its ascent. Each gossamer thread, under the tension of the insect's own weight, is reeled on a wire fork—which has been lightly coated with shellac to hold the filament in place—and carefully stored away until needed.

A saving of at least $250,000 has been effected during 1929 by twenty slate quarries in the Pennsylvania district through the use of the wire saw, according to a statement made by Dr. Oliver Bowles, of the United States Bureau of Mines, after a recent survey of the industry. Thirty of these saws are now in regular service at the plants in question. Aside from greatly reducing production costs, they do their work with far less wastage of the raw material than the machinery previously employed.

Left—Where mules provide the horsepower needful to crush ribbon cane in the process of extracting its sweet juice. Right—Interesting as the setting is, the steam is rising from an evaporating pan and not a still. Here it is that the cane juice is boiled until it becomes a syrup.

Cane Syrup for Southern Pancakes

A PICTURESQUE phase of agriculture in certain sections of the South is the annual activity of producing syrup from sugar cane. The rural dweller the country over is keen for sweetening in one form or another; and his consumption each year of this energy-giving foodstuff is generally higher than that of his fellow citizen in town or city. This is a fact not commonly known.

In those parts of the South where cane is not cultivated primarily for the making of sugar it is grown to provide syrup, which is extensively and variously used both on the farm and by people living in villages and larger communities in the region. Cane syrup is good on cakes and waffles; and cane syrup is commonly poured on biscuits carried by field workers to the scene of their labors and by youngsters that must eat their noonday bite in the immediate vicinity of the schoolhouse. The syrup both tickles the palate and compensates for the energy expended on the land or in romping, as the case may be.

While much of the cane syrup is turned out by fairly well equipped plants that grind or crush the cane with gasoline-driven rollers, still a very considerable percentage of the syrup made seasonally is produced with rather simple equipment and under conditions that have the colorfulness of the past. The accompanying illustrations show such an old-fashioned plant in Georgia that was "snapped" in full blast about the middle of last November. The horsepower for the crusher rollers was furnished by a pair of mules that trod patiently the circle described by the operating pole. The exuding juice was led into a conveniently placed barrel from which, after a brief period for settling, it was led by pipe to an open evaporating pan that surmounted a furnace built of brick. The furnace was rectangular, as was the pan on top of it; and at one end was a chimney and at the other was an opening into which wood could be shoved for fuel. This type of evaporating pan, while far from modern, has replaced the wide-mouthed iron kettles that were first used in the South generations ago for syrup-making.

The pan, typical of the sort widely employed by the syrup maker handling the cane of numerous small growers, was fashioned of sheet copper and was shallow. A series of parallel, vertical partitions or baffles—each secured at one end to a side of the pan and open at the other end, and arranged so that the openings alternated— served to divide the pan into a succession of interconnecting compartments through which the juice meandered progressively from the point where the fresh juice entered to the discharge end where it came out in the form of concentrated syrup. The man in charge of the boiling saw to it that his fire was hottest near the discharge or chimney end of the furnace; and as the water content was evaporated he continually skimmed the boiling juice to remove certain impurities.

In the course of a day, that plant was capable of turning out from 30 to 40 gallons of syrup; and the owner of the outfit stated that he got around $1.50 a gallon for the product. Probably the farmer that furnished his own sugar cane had to pay less for the syrup than one who did not. At $1.50 a gallon there might be a temptation to uncork a jug and permit fermentation to take its natural course. Indeed, low-density syrup will inevitably ferment unless heated and preserved in airtight containers. Cane syrup can develop a fairly powerful kick should its possessor neglect to take the precautions just mentioned.

Ribbon cane and what are known as Chinese canes are extensively grown in the South for syrup-making. These canes are harvested in the fall and when still immature; and, although relatively low in their sugar content at that time, they yield a juice that is excellent for the production of syrup. Likewise because of their moderate sucrose content, the syrup made from them is uncertain in its keeping qualities if exposed to the air. This fickleness has its own compensations; and, as one farmer remarked: "Gol darn it, why should I bother if it gets het up! I might still find a way to use it. How about it stranger?"

In the fall, one sees wagon after wagon laden with stalks of sugar cane wending their several ways to the nearest of these open-air syrup-making plants; and most of the cane comes from small patches that are counted upon by each grower to furnish him and his family with much of the sweetening used by them for months to come. Cane for this purpose, because it is not raised for the manufacture of sugar but for syrup only, can be cultivated successfully over fairly wide reaches of the Southland. The syrup-making plant of the southern states is that section's counterpart of the maple-sugar camps of the northern states, and equally a feature of the regional agricultural life. An acre of cane will yield on an average 140 gallons of syrup, according to the latest figures; and in 1928, the sugar cane grown in Georgia, for example, produced 4,060,000 gallons of sugar-cane syrup.

Power from sludge gas is being produced and used to advantage at the Saltley Works of the River Tame and Rea District Drainage Board, England, where two gas engines—one of 150 and the other of 400 b.hp.—have been provided for the purpose of converting the sludge gas into useful energy. To take full advantage of the gas available, a third engine of 400 b.hp. is now to be installed. With this equipment it will be possible to generate 2,000,000 electrical units a year, or two-thirds of the current that will be required annually to operate the Saltlev Works, which are now being completely electrified.

ORIFICE METERS FOR MEASURING LARGE VOLUMES OF GAS

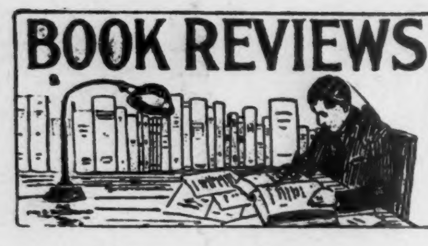
CONSIDERABLE progress has been made during the past year by the Measurement Committee of the Natural Gas Department of the American Gas Association in its investigations of orifice meters for measuring large volumes of gas. This notable work has been going on now for several years in coöperation with the Bureau of Mines and the Bureau of Standards, as well as the industry in question, and is fast drawing to a close.

According to the report for 1929: The first important step was a short series of high-pressure tests which were made in the Buttonwillow gas field near Taft, Calif. In these tests the line pressures were increased to over 600 pounds per square inch. Several tests were made on samples of the gas to determine the supercompressibility factor—that is, the amount by which the gas deviates from Boyle's law. As a result of these tests it was concluded that if the supercompressibility factor is correctly determined and applied to the meter computations, measurements by orifice meters may be made at high static pressures with the same degree of accuracy as at low pressures.

The next step was a series of tests at low pressure on 16-, 8-, and 4-inch lines. These three test lines were used successively in series with a bank of 10-inch lines which were used as reference meters. The set-ups for the three lines were made as nearly geometrically similar as was conveniently possible without excessive alterations in the rest of the piping system. There were three important elements associated with these tests: First, it was possible to obtain almost any rate of flow up to 2,000,000 cubic feet per hour; second, because of this large flow it was possible to extend the ratio of orifice to pipe diameter to 0.86 (for example, a 7-inch orifice in the 8-inch line), and in the case of the 4- and 8-inch lines to increase the gas velocity through these large orifices up to about the critical velocity; third, the same set of reference lines could be used throughout.

The most important conclusion that may be drawn from a preliminary study of the results is that for the same diameter ratios the value of discharge coefficient of an orifice is independent of the actual pipe size, provided the installations are geometrically similar, including the design and location of straightening vanes. It also appears that when the static pressure is taken on the upstream side of the orifice, the coefficient-pressure ratio curve is very nearly a straight line.

Refining the Crude is the title of the newest educational moving picture produced under the direction of the United States Bureau of Mines and the Department of Commerce in coöperation with one of the country's leading oil producers. The film is now available for distribution to schools, churches, clubs, civic and business organizations, etc., and may be obtained by addressing the Pittsburgh Experiment Station of the United States Bureau of Mines, Pittsburgh, Pa. No charge, other than the cost of transportation, is made for the loan of the reel.



ECONOMIC RESOURCES AND INDUSTRIES OF THE WORLD, by Isaac Lippincott, Ph.D. An illustrated work of 656 pages, published by D. Appleton & Company, New York City. Price, $5.00.

THE last three decades have emphasized the increasing interdependence of industrial nations for raw materials and for markets in which to dispose of the surplus of home industries. Therefore, Doctor Lippincott's work is especially timely, and particularly so because it is comprehensive in its scope. A realization of this state of affairs may prove a potent aid in perpetuating peace as well as in promoting prosperity.

Businessmen interested in any manner in foreign trade; students of international marketing and economic geography; and bankers and financiers will severally find of value to them this fairly complete world's survey of economic resources and the industries based thereon. Even apart from the economic or business aspect of the subject, the book contains fascinating passages that reveal the origins of many of the commodities with which we are intimately familiar as users but about which we know little as to sources. The book is a veritable compendium of absorbing data of materials and products from all corners of the globe.

TWO THOUSAND YEARS OF SCIENCE, by R. J. Harvey-Gibson, Emeritus Professor of Botany in the University of Liverpool. An illustrated volume of 362 pages, published by The Macmillan Company, New York City. Price, $4.00.

THIS work is the result of a request by a friend of the author for the name of a book of reasonable size that would give a general sketch of the growth of science from early times down to the present day. Failing to find such a book, Professor Harvey-Gibson set about producing one, and the volume now considered is the outcome. The present age and generation is of an inquiring turn; and this new book will be found to contain lucid and brief expositions of the many phases of science that have come into being in the last 2,000 years, and especially within that wonderfully prolific period of the last half century.

HEALTHFUL LIVING, by S. E. Bilik, M. D. A book of 261 pages, published by Charles Scribner's Sons, New York City. Price, $2.50.

THE author tells us in his preface that his book would have little warrant for appearance if he merely rehashed what has already been said and written on the subject of healthful living. He points out that most books on personal hygiene have been written by laymen, who have often been weak in scientific knowledge while overstrong in their faith in the infallibility of the methods advocated by them. Doctor Bilik writes as a physician and as one who has spent fully eighteen years in rather "intensive study of problems of conditioning men, women, and children"; and he tells us that he has helped thousands to retain or to regain good health. Possibly, many of us may profit by what he has written.

THE SECRETARY'S HANDBOOK, by Sarah Augusta Taintor and Kate M. Monro. A volume of 372 pages, published by The Macmillan Company, New York City. Price, $3.50.

THERE are secretaries and secretaries—the title is not always warranted, judged by the fitness of those designated to discharge the duties of such an office. Strictly speaking, a competent secretary should be to a man of affairs what a trained nurse is to a physician; and to meet such requirements the secretary should have an education, a knowledge, and an ability that do not come with a mere familiarity of stenography and a certain mastery of the touch-system of typing. The authors have compiled a handbook that is designed essentially to help in a specific department of a secretary's duties—that of writing letters and other business forms; and we believe this little volume will serve its purpose well.

CANALS AND INLAND WATERWAYS, by George Cadbury and S. P. Dobbs. An illustrated book of 160 pages, published by Isaac Pitman & Sons, New York City. Price $2.25.

WHILE this book has to do specifically with the inland waterways of England, where operating circumstances and practices differ in some respects from those imposed by conditions in this country, still England's system of internal water transportation can teach us much that could be profitably applied to the utilization of our own canals and inland water routes. One of the authors, in a foreword, has this to say: "The subject of canals is one that has been much misunderstood in recent years. While the public generally has some knowledge of the relative advantages and limitations of railway and road transport, there are comparatively few who appreciate the commercial existence or legitimate sphere of usefulness of inland waterways which penetrate the very heart of a country. This is probably largely due to the fact that, as there is no passenger traffic, their work is more or less out of sight and not in the eye of the public, as is traffic on the roads or rail."

The authors dispassionately discuss the merits and demerits of England's inland waterways; point out where some canals should never have been built; make clear why some of those artificial routes have failed to measure up to expectations; and also make it equally clear how certain of them could be utilized today to greater advantage and for the common good. Perhaps these lessons may be of value to us.

X-Rays in Industry is the title of an interesting pamphlet issued by the Eastman Kodak Company, Rochester, N. Y. The purpose of the booklet is to suggest ways in which X-rays can be used in industry in inspecting the internal construction of opaque materials.

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